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EIGHTEENTH MEETING OF THE AMERICAN ASTRONOMICAL SOCIETY.

[*Continued from page 604.*]

A STAR HAVING A LARGE COLOR-INDEX.

By Henrietta S. Leavitt.

In the year 1896 a photographic study of sixteen circumpolar variables of long period was begun at the Harvard College Observatory. Plates for this purpose had been taken regularly since 1890. The 8-inch and 11-inch Draper telescopes were used, and the observations were usually well distributed in all parts of the light curves. The limiting magnitudes varied from the thirteenth to the fourteenth.

The variable S *Cephei* was looked for in 1896, without success. Several suspected objects proved to be defects. The difficulty was easily explained by the extreme redness of this object, but, as we had no definite knowledge of the photographic scale of magnitudes, no value for the color index was obtained. Now we have two excellent photographs taken with the 16-inch Metcalf telescope on ordinary, or blue, plates, and four taken on isochromatic plates with a yellow screen. Blue plates were taken simultaneously with the 4-inch Cooke telescope attached to the larger instrument. We also have plates with the 8-inch Draper, showing stars as faint as the fifteenth magnitude.

The color equation of the 16-inch and 4-inch telescopes is about 0.8 magnitude for blue, and −0.2 magnitude for yellow light. Comparisons of plates of the two colors give a difference of 1.0 magnitude which may be called the normal color equation. The color equation of the 8-inch is about 1.0, and comparisons with visual magnitudes should give color-indices on practically the same scale as comparisons of blue and yellow plates taken with the 16-inch and 4-inch telescopes.

The variable is not seen on any of the blue plates taken with the 4-inch telescope, although one of the corresponding yellow plates shows it conspicuously bright, with the magnitude 7.7. This would indicate a color-index of more than five magnitudes. A lantern slide showing two photographs taken with the 16-inch telescope with exposures of ten minutes, was exhibited. The yellow plate taken September 13, 1914 showed the variable of magnitude 9.3. The blue plate taken two days later, September 15, though showing stars fainter than the sixteenth magnitude, gave no trace of the variable. This would indicate a color-index of at least six and a half magnitudes. The visual light curve shows the variable of the magnitude 10.0 on each date. Direct comparisons with the visual curve for three plates taken with the 8-inch telescope in 1897 and having long exposures, give for values of the color-index 6.0, 4.9, 6.1 magnitudes respectively. The visual curve depends on observations by several persons and is doubtless affected irregularly by their individual color equations. The value 4.9, which is much smaller than any other, may be affected by this fact, or there may be a real variation of color-index.

Of the five values of the color-index above mentioned one is of the magnitude 4.9, one certainly greater than five magnitudes, and three six magnitudes or greater. The most probable value is perhaps about six magnitudes. None of the comparisons were made near minimum and it is not known at present whether the color-index is constant or not.

An observing list of very red stars is now in preparation with the intention of photographing the stars with blue and with yellow light on the same nights.

PRELIMINARY REPORT ON GENERAL STELLAR PARALLAXES IN ZONE +45° OF THE SELECTED AREAS.

By Oliver J. Lee.

The work of securing plates with the 40-inch refractor for the determination of parallaxes and proper motions in the zone +45° of the Selected Areas was begun in October 1910. At the present time about one half of the necessary plates have been obtained. It is expected that two more years will suffice for getting the remaining plates and making the reductions. Professor Parkhurst has made the task of determining the photographic and photovisual magnitudes of all the stars measured for parallax a part of his program and hopes to complete that part of the work within two years.

So far I have reduced two fields definitely. The region K 29 ($9^h\ 39^m$, +44° 50′) has 21 stars, of which one is a BD star and none are much

fainter than the 12th magnitude. The upper limit of the probable error of one parallax in this field is ±0″.0174. Seven plates, each having one exposure, were used. In the region K 39 ($19^h\ 47^m$, +44° 55′) 90 stars were included in the reductions. Many of these were very faint and some should have been omitted. The upper limit of the probable error of a parallax in this field is ±0″.0206. Ten plates were measured.

The size of the real probable error is not known as yet. Efforts will be made to determine it. It probably will be appreciably smaller than the upper limits given above.

STELLAR PARALLAXES DERIVED FROM PLATES TAKEN WITH THE 40-INCH REFRACTOR OF THE YERKES OBSERVATORY.

By Oliver J. Lee and Alfred H. Joy.

The following parallaxes have recently been determined by the writers. The methods heretofore employed at this observatory have been used for these stars.

Star	R.A. h	R.A. m	Mag.	Spec.	μ	Rel. π	p. e.	No. of Plates	No. of Comp. Stars	p. e. of One Plate
					″	″	″			″
β Persei	3	2	Var.	B8	0.01	+0.020	±0.014	13	3	±0.035
θ Can. Maj.	6	49	4.5	K5	0.18	+0.012	±0.007	11	5	±0.016
Lal. 15565	7	54	7.5	G	0.12	+0.055	±0.013	10	5	±0.026
D'Ag. 1623	8	49	7.0	—	0.43	+0.012	±0.010	12	3	±0.025
A Oe. 10642	10	7	9.0	—	0.70	+0.069	±0.009	13	5	±0.020
λ Ophiuchi	16	26	3.8	A	0.10	+0.018	±0.003	13	4	±0.008
β G.C. 9919 A	20	2	7	O	...	+0.008	±0.008	12	6	±0.022
Companion D			9	—	..	0.000	±0.012	12	6	±0.032
BD 29°4753	22	41	7.2	—	0.44	+0.027	±0.011	14	7	±0.026

A test is being made by Mr. Lee of the method proposed by Kapteyn (Astrophysical Journal, **41**, 77, 1915) for eliminating the magnitude error from parallax determinations.

PARALLAX WORK AT THE UNIVERSITY OF VIRGINIA.

By S. A. Mitchell.

Parallax measures were made from photographs taken with the 26-inch Clark telescope of the Leander McCormick Observatory. The method followed was that of Schlesinger, and Slocum and Mitchell as published in the Astrophysical Journal.

Star	R.A. 1900.0	Decl. 1900.0	BD Number	Mag. and Spectrum	μ	π	p.e.	No.of Plates	p. e. of One Plate
	h m	° ′	°		″	″	″		″
70 Ophiuchi A	18 0	+ 2 30	2(3482)	4.1 K	1.12	+0.145	±0.007	17	±0.022
70 Ophiuchi B	18 0	+ 2 30		6.1 K	1.12	+0.165	±0.007	17	±0.022
Cygni 6 A	19 10	+49 40	49(2959)	6.6 K	0.66	+0.051	±0.006	16	±0.018
Cygni 6 B	19 10	+49 40		6.8 K	0.66	+0.036	±0.007	16	±0.022
θ Cygni	19 33	+49 59	49(3062)	4.6 F5	0.24	+0.080	±0.011	17	±0.034
β G.C. 9602	19 42	+33 23	33(3582)	7.5	0.45	+0.037	±0.011	17	±0.038
17 Cygni A	19 43	+33 30	33(3587)	5.1 F5	0.45	+0.080	±0.012	17	±0.037
17 Cygni B	19 43	+33 30		8.1	0.45	+0.046	±0.008	17	±0.029
β Aquilae	19 50	+ 6 9	6(4357)	3.9 K	0.48	+0.066	±0.011	15	±0.031
γ Delphini A	20 42	+15 46	15(4255)	4.5 G5	0.20	+0.071	±0.009	15	±0.025
γ Delphini B	20 42	+15 46		5.5 G5	0.20	+0.063	±0.009	15	±0.024

A REQUEST FOR METEOR OBSERVATIONS.

By S. A. Mitchell.

The systematic observation of meteors affords a splendid opportunity to the amateur to do valuable work in astronomy. No telescope or other equipment is necessary. Those who are willing to assist in making meteor observations are requested to write to the Leander McCormick Observatory, University, Virginia and there will be sent in reply maps of the sky and printed instructions which may be readily followed by any one familiar with the constellations.

PHOTOGRAPHS OF THE NINTH SATELLITE OF JUPITER.

By Seth B. Nicholson.

The Ninth Satellite of Jupiter was discovered on plates taken with the Crossley reflector at the Lick Observatory on July 21 and 22, 1914. These exposures were made for the purpose of securing observations of the Eighth Satellite. The lantern slides shown were made from the discovery plates.

FORMULAE FOR SPECTROSCOPIC BINARY ORBITS OF SMALL ECCENTRICITY AND FOR SYSTEMS SHOWING TWO SPECTRA.

By G. F. Paddock.

In the determination of nearly circular spectroscopic orbits the usual graphic and differential formulae become difficult of application for the evaluation of the small eccentricity and the angle of periastron. The paper contained new adaptations of the differential and analytic formulae

for use in the case of small eccentricity. Moreover, for the case when two spectra are visible so that measures of velocity of both component masses are available, a new combination of formulae was suggested for the purpose of employing both velocities and for the derivation of a consistent system of elements of the component orbits.

From the two equations representing the velocity in the line of sight of the two masses respectively of a binary system are derived: first, the equation containing as unknowns the radial velocity of the center of mass and the ratio of masses; second, the equation containing the orbital elements. The first equation and the differential of the second have been adapted to convenient application and computation and into both may be entered simultaneously the measured velocities of both component masses. The resulting series of equations are to be solved by least squares for the quantities mentioned. For the case of very small eccentricity, the second equation has been developed analytically into a particular form of Fourier series in terms of the small eccentricity and multiples of a phase angle reckoned from an arbitrary epoch. An endeavor has been made to include all second order terms but the result shows that only part of these may be retained in a least squares solution. Special adaptions for convenient computation have been introduced. The total result is a form of rigorous solution by least squares for the eccentricity and the angle of periastron without a preliminary assumption of their values.

The developments given were suggested by the problem presented by the spectroscopic binary υ_4 *Eridani* which shows two spectra the measures of which indicate nearly circular orbital motion. Although the method requires more than usual accuracy in the observed velocities, it has been applied to this binary system for the purpose of illustration. The results together with a discussion of the physical constants of the system are given in the following paper.

(This paper will be published in full in a *Lick Observatory Bulletin*).

THE SPECTROSCOPIC BINARY υ_4 ERIDANI.

By G. F. Paddock.

The binary system υ_4 *Eridani* gives two equally bright spectra of Class B9. The hydrogen line H_γ at λ 4340 is strong and broad and not always measurable. The magnesium line at λ 4481 is strong and fairly well defined. Many faint lines are visible on those plates on which the two spectra are coincident. From one of these plates the wavelengths and identifications of 40 lines were determined showing that the

spectrum contains besides hydrogen the enhanced lines of iron, titanium, manganese, chromium, and magnesium. The spectrum is essentially Sirian.

Of the 61 plates obtained of this binary, 39 showed the two magnesium lines at λ 4481 distinctly separated. The measures of these alone were used for the solution of the orbit which was obviously nearly circular. For the derivation of the small eccentricity and nearly indeterminate angle of periastron the analytic formulae discussed in the preceding paper were employed. The circumstance that the observed velocities were not sufficiently accurate for the application of these formulae was set aside in order to illustrate the methods. Two least squares solutions were performed, one for the velocity of the system and ratio of the masses, and one for the orbital elements, with the result that the elements are given for the system and for each component mass on a consistent basis. A comparison of these elements with those of other binary systems shows that this system is one of average and normal values.

The star is not far from the antapex of the Sun's motion and the observed velocity of the system is practically that due to the solar motion. The density is not improbably low like that of the eclipsing systems. The parallax is unknown but on the basis of Plummer's hypothetical parallaxes for Class A stars, υ_4 *Eridani* has a parallax of 0".03 and is one of a star group of similar spectral class and similar motions. On the basis of a probable orbital inclination, low density, and the hypothetical parallax, the physical system of υ_4 *Eridani* may be thus described: The component masses are somewhat less massive but slightly larger than the Sun, having an intrinsic luminosity at least eight times that of the Sun and a total luminosity of probably not less than 30 times that of the Sun.

The principal elements are:

$$
\begin{aligned}
P &= 5.010 \text{ days} \\
\gamma &= +17.8 \text{ km} \\
\frac{m_2}{m_1} &= 0.9832 \\
e &= 0.01 \pm \\
K_1 &= 63.8 \text{ km} \\
K_2 &= 64.8 \text{ km} \\
(a_1+a_2)\sin i &= 8800000 \text{ km}
\end{aligned}
$$

(This paper will be published in full in a *Lick Observatory Bulletin.*)

AN APPARENT RELATION BETWEEN THE INHERENT RADIAL VELOCITIES OF THE BRIGHTER STARS AND THEIR MAGNITUDES.

By C. D. Perrine.

Tables were shown, exhibiting the results of an examination of the stars of the six principal spectral classes with respect to inherent radial velocities and magnitudes. The data are from Campbell's catalogs of radial velocities. Making a reasonable allowance for the effect of a few abnormal velocities, an increase of velocity with decrease of brightness is clearly exhibited. There appears at first sight to be an exception in the case of the class A stars but a closer examination indicates that this exception is due to seven of the brighter stars in the Milky Way having large velocities. At least three of these belong to the Ursa Major stream.

As the stars concerned in the investigation amount to about half of those of fifth magnitude and brighter it is believed that the above condition is representative of such stars. How far it may extend below the fifth or sixth magnitude is uncertain.

Strong corroboration of this conclusion is found in the fact that the highest velocities are found only among the fainter stars—not a single instance to the contrary being known. Of the 38 stars in the list having velocities of 50 km and greater, only one is as bright as 2.4 magnitude and four are between 3.0 and 4.0. There are five stars of 100 km and greater, the brightest of which is 5.2 magnitude—the mean magnitude of the five being 6.9.

An examination showed also that the largest number of great velocities, the greatest velocities, and the highest average for the large velocities occur generally in classes F and G. As these stars are in general the nearest to us, their absolute brightness must be much less than stars of earlier and later classes of the same apparent brightness.

The cause of such a dependence upon magnitude may be obscure, but at first sight it seems most likely to result from one of two causes:

1. A difference in size or density or both, in conjunction with some form of resisting medium.

2. That the fainter stars are those which are farther away from the observer and nearer to a source of general gravitational action.

That the Milky Way is deeply concerned in either case seems probable.

SOME PECULIARITIES OF AN APPARENTLY SEMI-SYSTEMATIC NATURE IN THE RADIAL VELOCITIES OF THE BRIGHTER STARS OF DIFFERENT SPECTRAL CLASSES AND THEIR EFFECT UPON THE SOLAR MOTION.

By C. D. Perrine.

While investigating the relation between radial velocities and magnitudes I noticed in some of the classes a tendency of the velocities in some regions to differ systematically from those in other regions. Further examination confirmed the earlier suspicions and led to an examination of all the classes. The following conclusions are drawn.

1. That the values of the solar motion derived from the spectral classes separately show large and systematic variations.

2. That the values of the solar motion and the residual motions show large variations in different regions of the sky and within the same spectral class.

3. That the constant error, together with the solar motion, derived from each spectral class varies in such a way that the algebraic sums of these two quantities are in very good agreement. This gives rise to the suspicion that these quantities are still closely related.

4. It is believed that the chief cause of the discordances noted is to be found in systematic or semi-systematic motions of the stars themselves. That in the case of the class A stars a better representation was obtained by the assumption of preferential motion, the resulting value of the solar motion being also in better agreement with that obtained from all of the classes.

5. The systematic variations in the values of the solar motion, constant error, and residual motions of the stars of different spectral classes noted above, taken in connection with similar systematic variations in the proper motions and parallaxes of the spectral classes, lead to the suspicion that they result largely from gravitational action of the matter composing the Milky Way.

THE SOLAR ECLIPSE OF 1916 DECEMBER 24-25.

William F. Rigge.

This eclipse is of exceptional theoretical interest in that: 1. Its greatest magnitude is only 0.011. 2. It occurs near the winter solstice. 3. It is visible on the Antarctic Circle beyond the South Pole. 4. It progresses westward against the diurnal rotation, instead of with it, or eastward, as usual. 5. It is visible in some places at local midnight. 6. It is an eclipse of the Christmas midnight Sun.

The first of two charts exhibited was in the usual Besselian projection, and showed the Moon's penumbra overlapping only 0.0086 of the Earth's radius. The second was a map of the eclipse for time intervals of five minutes. (See *M. N.* **75**, 687, 1915).

THE SPECTRA OF STARS BELONGING TO CLASS R OF THE DRAPER CLASSIFICATION.

By W. Carl Rufus (*Introduced by R. H. Curtiss*).

Spectrograms of ten Class R stars (visual magnitude, 7.0 to 8.9; photographic magnitude, about 8.0 to 10.5) were made with the spectrograph attached to the 37½-inch reflecting telescope of the Detroit Observatory of the University of Michigan from July 1, 1914 to Apri 3, 1915.

Radial velocity determinations gave values ranging from −49 to +25 km per second, (average probable error ±1 km per sec.) with an average residual radial velocity of 14.9 km per second.

Wave-lengths of the heads of bands, absorption lines, and emission lines, were determined for the region λ 4185 to λ 5000, (probable error of the mean in ten stars ±0.05 Å). The following substances were identified: carbon (carbon monoxide and cyanogen), hydrogen, chromium, vanadium, titanium, iron, sodium, calcium, magnesium, nickel, and manganese.

The spectra of the first stars of this class R series, arranged in order of increasing strength of the carbon absorption bands, closely resemble the solar spectrum.

The chief difference between the spectra of these stars of Class R and stars of Class N is due to the stronger general absorption in the latter class.

Comparison of Class R with Class G and Class N with reference to color-index, distribution, number of variables, shift in wave-length of certain lines with spectral type, change in intensity of certain lines, the number and characteristics of bright lines, hydrogen lines, and cyanogen flutings, indicates that Class R follows Class G and precedes Class N in the stellar evolutionary sequence taken in the usual order, B,A,F,G,K,M.

A marked correspondence exists between Classes R and K in color-index, distribution with reference to galaxy, residual radial velocity, tendency to variability, similarity of absorption lines, bright lines, cyanogen flutings, λ 4227, and hydrogen lines.

The evolutionary sequence divides apparently at the solar type, Classes K and M forming one branch, and Classes R and N forming the other.

Stars of Class R appear to form the connecting links between Class N and the solar type.

A DESCRIPTION OF THE THAW REFRACTOR OF THE ALLEGHENY OBSERVATORY.

By Frank Schlesinger.

This 30-inch photographic refractor was installed in September 1914. The performance of the instrument proves excellent in every respect. The objective satisfies the Hartmann test as well as any other for which the details have been published. The material in the lens is extraordinarily transparent to photographic light, so that very short exposures are sufficient for most of the purposes to which the telescope is being applied. It was found early in the experience with this objective that it was sensitive to changes in temperature. Special ventilating devices were installed to overcome this, and they have removed the difficulty. It was shown that other large objectives are probably equally affected in the same way, and that the use of similar devices would probably improve their performance to an equal extent. The detailed paper is to appear in Volume 4 of the Publications of the Allegheny Observatory.

THE SPECTROSCOPIC BINARY σ SCORPII.

Miguel Selga, S. J.

The variation in the radial velocity of σ *Scorpii* ($16^h\,15^m.1$; $-25°\,21'$) was established by Dr. V. M. Slipher from four plates taken at the Lowell Observatory in June and July of 1904.* Sixteen one-prism spectrograms were measured and reduced by the writer at Flagstaff in the spring of 1914. One hundred and nineteen plates, obtained with single light-prism spectrograph attached to the 36-inch refractor of the Lick Observatory, were measured and reduced by the writer at Mt. Hamilton late in 1914 and in the spring of 1915.

The writer was fortunate in obtaining on May 26, 1915, eleven one-prism plates, on June 22, seventeen one-prism plates, on June 25, twelve one-prism plates, and on July 22, sixteen one-prism spectrograms. Each of these series of plates shows decidedly that the star's radial velocity passed through its whole cycle in the short interval of 0.25 of a day. The value $0^d.246829$ was found to give a periodic grouping of all observations from 1902 to March 1915. This period, suggested by the curve of May 26, 1915, was confirmed by the complete curves of June 22 and 25. It is the second shortest period thus far found and gives more than 20000 revolutions since the first observation of the radial velocity of the star.

* *Lowell Observatory Bulletin*, No. 11, Vol. 1, 1904.

The large residuals given by the three- and one-prism spectrograms, both at the Lick and the Lowell Observatories, the fact that the velocity of the system was 6 km higher on May 25 than on June 22, and finally, the lower maximum velocity observed on July 7 and the higher minimum velocity on July 22 are strong indications of a variation in the velocity of the center of mass of the system.

From the plat of the twenty-nine observations of June 22 and June 25, a set of elements was derived by the Lehmann-Filhés method.

The H and K lines of Calcium were reported by Dr. V. M. Slipher as yielding constant velocity. From the examination and measures of sixty plates, showing a range of velocity of 110 km for the K line, it is apparent that the Lick spectrograms do not confirm the early observations of the Lowell Observatory.

PHOTOGRAPHIC MAGNITUDES IN THE SELECTED AREAS.

By F. H. Seares.

A program for the determination of photographic magnitudes in the Selected Areas was outlined at the sixteenth meeting of the Society (See also *Pub. A. S. P.* **26**, 51, 1914). In the meantime considerable progress has been made both with the observations and the reductions; the present state of the work is as follows:

Of the 460 diaphragm plates required for the determination of the scale, 100 are still to be secured. For the determination of the zero point, a total of about 300 intercomparison plates will be needed, of which one-third have already been obtained.

187 plates have been completely measured; 12 plates have been measured once. For 36 areas the measures are complete, while for 24 others one-half of the work is finished. The reductions, exclusive of the zero-point determination, are complete for 26 areas. Although these are mainly in the intermediate or higher galactic latitudes, the fields (diameter 23′, maximum exposure 15 minutes) show an average of about 125 stars per area. Four areas near the Milky Way (mean galactic latitude $= 4°$) show a mean of 1400 stars per field.

The reduction to the international zero point is effected by the intercomparison of all the areas in each zone, and by the further comparison of certain areas with the pole. For the latter, six areas in each zone uniformly distributed in right ascension, have been selected. All of the comparison plates will be in duplicate.

MAGNITUDES AND COLORS IN THE HERCULES CLUSTER.

By Harlow Shapley.

The study of the colors of the stars between magnitudes 12 and 15.5 in the Hercules cluster yields the following principal results:

1. Of the 1049 stars the color-indices are distributed as follows:

No. Stars	Color-Index
113	<0.0
153	0.0 to $+0.4$
328	$+0.4$ to $+0.8$
357	$+0.8$ to $+1.2$
78	$+1.2$ to $+1.6$
20	>1.6

From the above we conclude that the absorption in space, in the direction of this cluster at least, is negligibly small, and at most is not greater than 0.0002 magnitude per unit of distance.

2. The average color-index decreases with distance from the center, indicating either a concentration of red stars toward the center or an absorption of light peculiar to the cluster itself. The evidence supports the latter interpretation.

3. The average color decreases with decreasing brightness. That is, the brighter stars of the 1049 studied, are red; the fainter ones, blue.

4. The distance of the cluster is of the order of 100000 light years.

THE EVOLUTION OF A GRAVITATING, ROTATING, CONDENSING FLUID.

By Elliott Smith.

In this paper the attempt was made to trace the evolution of a star from the condition of a nebula to that of a dark body by assuming that originally the motions of its component particles or molecules are orbital. In this condition the particles present the problem of the orbital motion of n bodies.

By mutual impact, the particles give up as radiant energy the kinetic energy due to their motions. The motion lost represents a decrease in velocity of the particles in their orbits or oscillations and consequently a decrease in the centrifugal force acting outward to maintain them in their positions in the configuration.

Radiation takes place at the surface of a star. Hence, the radiant energy emanating from a star represents molecular motion given up by particles at its surface, and also a loss of force acting outward to maintain them at the surface.

An interchange of particles between surface and interior must, then, be continually taking place, either uniformly or in periodic time.

If in periodic time the interchange is of the form of an eruption in the star's surface and the accompanying light and velocity variations are indicative of the wave motion produced within the star, the light and velocity curves may be interpreted as indicating stellar wave motions.

A conclusion of importance as to the source of radiant energy of the Sun or a star is contained in the formulae derived. It is shown not only that the energy of the fall of particles toward the center of mass with contraction, as discussed by Helmholtz, is contributed to solar and stellar radiant energy, but also that transformed, intrinsic, molecular, kinetic energy constitutes an important source of solar and stellar radiant energy.

SOLAR ROTATION IN 1914-15.

By Charles E. St.John, Walter S. Adams, and Louise W. Ware.

During the period 1914-15 four series of plates have been taken with the first order of the 75-foot spectrograph (scale 1mm =0.7 Ångstrom). The light has been taken from a point 3 mm within the edge of an image 410 mm in diameter formed by the 150-foot vertical telescope. The regions of the spectrum are: (a) In the violet λ 4123—λ 4340 (b) In the green λ 5018—λ 5316; (c) In the red λ 6300—λ 6563 (d) The fourth series, λ 5018—λ 5316, has spectra of the two limbs and the center for the purpose of comparing the rotation values for the north and south hemispheres, and are also available for obtaining limb-center displacements.

The plates of series (a) and (b) have been measured for zero latitude. The measurements confirm the results previously obtained at this Observatory in showing differences depending upon the intensities of the lines, the stronger lines yielding the higher rotation values. For the three magnesium lines of the b-group (mean intensity 22), the equatorial velocity is 2.043 km per second, while for 22 lines of intensity 1—7 the mean equatorial velocity is 1.934 km per second. These results depend upon filar micrometer measurements made by three observers, the three series being in practical agreement. An effect depending upon the intensity of the lines is shown by the observations of 1906-07, 1908, and 1914-15 made with spectrographs of 18, 30, and 75-feet focus respectively, an effect not apparent in the determination at other observatories though obtained here by each of the four measures. In order to eliminate systematic errors possibly inherent in filar micrometer measurements upon lines differing widely in solar intensity, the

displacements between the east and west limbs for some typical lines have been measured by means of the curves obtained with the microphotometer. The preliminary results from six plates for three lines of intensity 2 and the two magnesium lines at λ 5172 and λ 5183 show systematic differences in the displacements of the same order as those shown by the filar micrometer measurements. The displacements in millimeters found by the filar micrometer are given in the upper, and those determined from measurement of the curves made by the microphotometer in the lower line of the following summary. The data refer to the same plates.

λ 5165	λ 5225	λ 5226	Mean	λ 5172	λ 5183	Mean
0.0842	0.0861	0.0858	0.0853	0.0892	0.0894	0.0894
0.0852	0.0859	0.0853	0.0855	0.0886	0.0878	0.0882

These systematic differences are interpreted as phenomena of level, the higher portions of the solar atmosphere rotating with greater angular velocity and with less equatorial acceleration.

When the equatorial velocities obtained from the displacements of the unenhanced lines are grouped according to their intensity a systematic variation is very apparent.

Intensity	1.0	2.0	3.6	6.5	22
No. of Lines	2	5	5	4	3
Equa. Vel.	1.924	1.933	1.937	1.954	2.043

The equatorial velocities for enhanced lines are slightly lower than for unenhanced lines of the same mean intensity, a result in harmony with that from the two earlier investigations. For 6 enhanced lines of mean solar intensity 3.2, the rotation value is 1.928 km, while for 5 unenhanced lines of mean intensity 3.6, it is 1.937 km.

From the 1906-07 series of Mount Wilson observations, the equatorial velocity found was 2.064 km and that from the 1908 series 2.053 km. In view of the still lower value obtained from the current series, 1.949 km, and the generally low values found by recent observers at epochs falling between the two last Mount Wilson series, the question of the constancy of the solar rotation may be seriously raised. This systematic decrease in the values found for the solar rotation emphasizes the need of entering upon a series of observations extending over a period of years. Such a series has been begun, and it is intended to obtain plates in zero and 45° latitude under the same observing conditions each month for a series of years.

THE VARIABLE 6.1914.

By Sidney D. Townley.

The variable 6.1914 was discovered by Madame Ceraski on Poulkova photographic plates and announced in February 1914.* The plates were obtained between 1908 and 1913 and showed a variation of magnitude from 9½ to 11, the light varying as much as one magnitude in an hour, indicating either a short period or an irregular variation.

My observations, 213 in number, were obtained in June, July, and August 1914 and June and July 1915. Rapid variation of light was early found but the observations of 1914 were so scattered that the period could not be determined with certainty. In June 1915, however, it was possible to make continuous observations for over five hours on several nights and on June 16 a well-defined maximum was obtained.

A preliminary discussion of the observations leads to a period of 13.78 hours. The approximate elements are:

$$M = 1915 \text{ June } 16\ 21^h\ 0^m + 13^h\ 47^m\ E = 2420665.875 \text{ d. j.} + 0.574\ E$$

Greenwich Mean Time (not reduced to Sun).

The star at maximum is about the tenth magnitude and the range is somewhat less than one magnitude. The curve is a typical Antalgol or Blinkstern type.

DESIGNATION OF VARIABLE STARS.

By S. D. Townley.

This paper gave some brief references to the earliest catalogs of variable stars and to the various systems of nomenclature which have been used. Argelander's system was described in detail and the objections to the system were pointed out.

There are three fundamental requirements that must be met in any system of variable star nomenclature which can hope for universal adoption. These are:

First. It must be simple.

Second. It must be capable of indefinite extension.

Third. It must not depend upon any particular epoch of time.

The Argelander method does not fulfill either of the first two requirements and is open to the further objection that it has not been made all inclusive, such variables as Algol, o *Ceti*, Polaris, etc., never having been given symbols in the Argelander system.

* *A. N.* **197**, 215.

It was suggested that the Argelander system be abandoned and the one proposed successively by Chambers, André, and Nijland be adopted. This system is to number the variables of each constellation in the order of discovery, letting each number be preceded by the letter *v* and followed by the name of the constellation, e.g. *v* 21 *Persei.*

The last part of the paper was given to answering the objections which Hartwig has raised to the proposed system.

(See Introduction of this Report for notice of appointment of Committee on Nomenclature of Variable Stars. The personnel is S. D. Townley, Chairman, Annie J. Cannon, and H. N. Russell.)

COMPARISON OF THE A. G. ZONE PLACES WITH RECENT OBSERVATIONS.

By R. H. Tucker.

About 600 A. G. zone stars from the catalogs of Nicolaief and Albany were observed at the Lick Observatory in 1914. One half of them, embracing the hours 6 to 17 inclusive, have now been reduced and the observations have been compared with the zone places, corrected for proper motions, when these were given in the original catalogs and confirmed by these observations.

Two thousand observations, including those of standard stars of the *Berliner Jahrbuch*, are included here. Each star has been observed twice fixed circle east, and twice fixed circle west. Corrections for the magnitude equation have been applied to the observations of Right Ascension.

The stars of this list are found, two thirds in the catalog of Nicolaief, and one third in Albany. The overlapping region was thoroughly compared by Dr. Auwers, including the differences with respect to magnitude, in both coördinates; and the stars common to both catalogs are not included here.

The mean differences are:

Obs. — Nicolaief	$-0^s.025$ and $+0''.23$
Obs. — Albany	-0.062 and $+0.30$

The respective differences of the two catalogs are:

N — A	-0.037 and -0.53
Auwers found	-0.070 and -0.70

for the same hours, for stars common to both. If the correction for magnitude equation be left out, the diflerences are:

Obs. — N	$+0^s.011$
Obs. — A	-0.024

The Lick Observatory places fall between those of the two catalogs, in both coördinates in this case, and the respective differences are smaller

than those between the original catalogs. The residuals also are smaller in general, as would be expected in the comparisons of accurate modern places with those of the zone catalogs.

If the probable errors of individual differences are compared with the probable errors of the original authorities, allowing for the known probable error of the L. O. observations, the outstanding errors might be attributed to proper motions of accidental character. The average proper motion of these stars, of mean magnitude 8½, would then be 0″.02 annually, on the arc of a great circle, for the elapsed interval of about thirty years.

CHRONOGRAPHIC REGISTRATION OF RADIO TIME SIGNALS.

By Frank D. Urie.

The Elgin National Watch Company, Elgin, Ill., is now obtaining chronographic records of the Arlington radio time signals at a distance of 700 miles. The recording apparatus, which was devised by the writer, is entirely automatic in operation, the incoming radio signals controlling the movement of the chronograph pen.

The antenna consists of four wires, each 280 ft. long and 150 ft. high, To this is connected an inductively coupled transformer, with galena detector. The rectified detector current is led to a series of amplifiers which intensify the Arlington signals sufficiently to operate a very sensitive relay, the back points of which control a 5 ohm relay, which in turn controls the chronograph circuit. The lag of the apparatus was found to be three hundredths (0.03) of a second.

In comparing the Arlington signals with the mean time clock, Riefler 224, of the Elgin Observatory, the writer has devised the following method for eliminating the consideration of the above lag. In our Radio Laboratory there is a relay operated by Riefler 224 which controls all the sounders in the factory. This factory circuit is strong enough to produce a small spark at the back points of the relay. This spark is of sufficient intensity to generate electrical waves which are audible in the radio receiver. These signals pass through the amplifying device, operate the sensitive relay and are recorded on the Chronograph in exactly the same manner as the Arlington signals. Hence any lag that may be present in the recording device will affect equally the radio time signals and the signals from the local clock, and is therefore eliminated from the discussion.

This recording device with some modifications was used at the U. S. Naval Observatory for determining the wire lag between the Naval Observatory and Arlington, Radio, Va. (See Popular Astronomy **23**, 588, 1915.)

CHRONOGRAPHIC DETERMINATION OF THE LAG BETWEEN THE ARLINGTON AND THE KEY WEST RADIO TIME SIGNALS.

By Frank D. Urie.

The apparatus used at Elgin, Ill., for chronographically recording the Arlington (700 miles) and the Key West (1250 miles) radio time signals has been described in the preceding paper.

While developing the radio recording device, the writer found that it was possible to record at Elgin, both the Arlington and the Key West radio time signals on the same chronograph sheet.

The determination of the time lag between Arlington and Key West was undertaken in January 1915 at the request of Capt. Hoogewerff, Superintendent of the U. S. Naval Observatory.

During February the investigation was interrupted by the destruction of our antenna in a sleet and wind storm. The antenna was replaced as soon as possible and the investigation was continued through March.

The plan was to record the first minute of Arlington; then tune to Key West and record the second, third, and fourth minutes; then tune again to Arlington and record the fifth minute. After the record is obtained, vertical lines are drawn on the chronograph sheet between the same seconds of the first and fifth minutes of Arlington. The lag of Key West can then be directly measured for every individual second.

The results of the lag determination are

1915	Number of Comparisons	Lag of Key West
Jan. 23	29	0.277 sec.
26	16	0.250
29	77	0.267
Mar. 8	22	0.240
10	48	0.120

Apparently there was some unusual lag on March 10 in the Arlington signals. This date has therefore been rejected.

The average result of the determination gives the lag between Arlington and the Key West radio time signals as + 0.258 sec. (See Popular Astronomy **23**, 589, 1915.)

PHOTOGRAPHIC DETERMINATION OF STELLAR PARALLAXES WITH THE 60-INCH REFLECTOR.

By Adriaan van Maanen.

An investigation to see what accuracy could be reached in the direct determination of parallaxes with the 60-inch reflector was started in July 1913. Since that time 401 plates involving 649 exposures have been taken. The equivalent focal length of 80 feet was used for the work.

The exposure time was as a rule 15 minutes. The Seed 23 plates used throughout these exposures yield stars as faint as magnitude 13.7, of which all but the faintest can be used as comparison stars. The advantage of using faint stars for comparison purposes is two-fold. The chance that they will have an appreciable parallax or proper motion is less, and a sufficient number of comparison stars can be found within a small distance of the principal star. In this way any errors depending on the quadratic terms of the coördinates of these stars become relatively small and can be neglected in the reductions. Except in one case eight or more comparison stars have been used; in no case has the distance from the principal star exceeded eight minutes of arc.

To cut down the light from the parallax star, so as to make its reduced magnitude nearly the same as that of the comparison stars, a small rotating sector with a diameter of two minutes of arc was used. The reduction of the light was from 5 to 6.5 magnitudes. The plates were all taken with hour angles less than fifteen degrees.

The plates were measured in pairs with the blink arrangement of a Zeiss stereocomparator, to which a few improvements had been made, principally to prevent heating of the instrument by the lamps used for illuminating the plates.

In combining the plates into pairs, before starting the measures, care was taken that the difference in hour angle between the two exposures to be compared might be as small as possible; this difference in no case exceeded five degrees and usually was smaller than two degrees. It will be clear that any hour angle error must in consequence be exceedingly small. The plates were measured in right ascension only, but in two positions differing by 180°.

13 stars have been measured and reduced.

Star	Parallax	Probable Error	No. of Exposures
	″	″	
Boss P.G.C. 96	+0.028	0.007	14
420	+0.004	0.007	14
672	−0.009	0.0045	14
1549	+0.001	0.0015	16
1868	+0.006	0.0035	16
2020	+0.004	0.005	14
2921	+0.078	0.006	10
3233	+0.003	0.010	12
3650	+0.096	0.003	12
4048	+0.038	0.010	10
4393	+0.013	0.005	12
4555	+0.024	0.0045	18
5210	+0.006	0.002	12

While the number of exposures used for the determination of a parallax is from ten to eighteen, the mean probable error is less than 0″.006.

It is not only necessary that the *probable* error be small; it is also necessary that there should be no *systematic* error of appreciable amount. A discussion of the 111 comparison stars shows, however, that there is no appreciable systematic error which is a function of the distance from the center, or of the magnitude, or which arises from the neglect in the reductions of the quadratic terms of the coördinates of the comparison stars.

FUNDAMENTAL DISTINCTIONS SPECIAL TO THE PROCESS OF TRANSMISSION OF TERRESTRIAL RADIATION BY THE ATMOSPHERE, AND THE VALUE WHICH IS OBTAINED FOR THE COEFFICIENT OF TRANSMISSION WHEN THESE ARE CONSIDERED.

By Frank W. Very.

If R is the terrestrial radiation in gram cal./cm^2 min. with a clear sky, for a pressure of atmospheric aqueous vapor at the Earth's surface of a in mm, we have these observed values:

Ångström (dry summer)	$a =$ 3.50 to 4.50	$R = 0.198$
Ångström (moist summer)	$a =$ 11.90 to 13.24	$R = 0.146$
Very (winter)	$a =$ 0.63 to 2.39	$R = 0.222$
Very (summer)	$a =$ 9.14 to 12.67	$R = 0.149$
Homén	$R =$ 0.22 to 0.13	

Since the observations are in good agreement, the diverse values which have been attributed to the atmospheric transmission of terrestrial radiation call for explanation and further discussion.

Low values of transmission (5 to 25%) are advocated by Mr. Anders Ångström in three articles published in the *Astrophysical Journal*, in complete disagreement with the values (26 to 58%) which I have deduced for summer and winter respectively (Popular Astronomy **22**, 147, 1914). These larger values are closely paralleled by the transmissions assigned by Homén and Ekholm, and similar ones are derived from my measures of the transmission of radiation emitted by the heated surface of the Moon through our atmosphere; which proves conclusively that the atmospheric transmission for radiation of planetary quality is of the order that I have assigned.

Ångström's conclusion rests on a fallacy, since he supposes that the larger part of an observed nocturnal radiation is not emitted to space, but to cooler layers of air at a height of 3000 m, which constitute "the effective radiating layer of the atmosphere". But I have demonstrated that practically all of the terrestrial radiation which the atmosphere is capable of absorbing disappears in the first few meters of air traversed by the rays, from whence the energy thus trapped escapes gradually after multitudinous transfers; and only in the outer parts of the iso-

thermal layer is the air free to radiate directly to space. This, therefore, is the radiating layer of the atmosphere, and the supposed function of the layer at 3000 m does not exist. The observed nocturnal radiation is a *radiation to space.*

A further discrepancy is that Ångström obtains positive radiant values from the sky by day, but negative at night, differing from both Homén and myself, who get negative values both by day and by night. I show that this seeming discrepancy comes from a difference in our methods of observation and is due ultimately to a fundamental distinction in the modes of depletion of terrestrial and solar radiation by the air. Sunlight, reflected from the sky, continues to move with the speed of light. Terrestrial radiation, absorbed by the air, is turned into air radiation on which some of the most important of the physical properties which we call "atmospheric" depend; but the propagation of this air radiation through the atmosphere is extremely slow, compared with that of light. This fundamental distinction is not considered in Ångström's method. His results are special to his method, and can not be understood, or correctly interpreted without a full discussion which is here only outlined. For further details my papers in the *American Journal of Science* (**34** 533, Dec. 1912; **35** 369, April 1913; **39** 201, Feb. 1915) should be consulted.

The support for his conclusions which Ångström draws from the work of Abbot and Fowle, where similar results are reached, should be turned in the opposite direction, and his failure to obtain correct values for the atmospheric transmission of terrestrial radiation should suggest that the theory of the other observers, on whom he leans, is inadequate, a view which is advocated on other grounds in my paper in the Publications of this Society, Vol. 2, p. 12.

THE SPECTRUM OF THE EARTH-SHINE.

By Frank W. Very.

With the coöperation of Dr. Percival Lowell and the indispensable skill of Dr. V. M. Slipher, spectrograms of the earth-shine on the Moon, comparable in intensity with others of the sun-illumined crescent, have been made at the Lowell Observatory on bathed plates which are sensitive to red light, and I have been able to make a series of quantitative measures of the photographic intensity throughout the visible spectrum by means of the band-comparator.

Owing to the faintness of the earth-shine, some of the problems of the photographic laws involved in this comparison of spectra were

unusual, and in fact insoluble, until a complete photographic and visual research had been accomplished. This, in itself, should be of interest to astronomical photographers.

The spectrum of the earth-shine consists of two parts: First, that of a very considerable amount of white light, evidently reflected for the most part from the cloudy contents of the Earth's atmosphere; and Second, there is, superimposed upon this general spectrum, a variable amount of a spectrum rich in blue rays, and in fact identical with the spectrum of the blue sky. It represents that portion of the loss by molecular scattering, the atmospheric, selective depletion of solar radiation, which goes back to space immediately from the clear air.

A portion of the solar radiation is reflected back to space even from the upper air, but a large part penetrates nearly, or quite, to the Earth's surface before it is turned back. Any gaseous or vaporous absorption which this part has undergone will be repeated (though not quite to the same extent, because some of the homogeneous rays have completely disappeared) while the rays are on their way out, and then for a third time when they came back after reflection at the Moon's surface. The greater strength of the violet absorption band, which extends between 0.40 and 0.46 μ, in the spectrum of the earth-shine, proves that this band originates in the Earth's atmosphere. Its strength is sufficient to appreciably displace the maximum of energy in the solar spectrum toward the longer wave-lengths.

From these spectrograms a value of the Earth's albedo has been obtained in close agreement with that from visual observations which I published in *A. N.* 4696. The demonstration of great losses suffered by the solar rays in passing through the Earth's atmosphere is complete and requires a solar constant of at least 3.5 cal./cm^2 min. to meet such large depletion, and yet to maintain the Earth's surface temperature.

THE SPECTRA OF THE GASEOUS NEBULÆ AND SOME POINTS OF CORRESPONDENCE BETWEEN THEM AND OTHER CELESTIAL SPECTRA.

By W. H. Wright.

The paper presents some general results derived from an examination of the spectra of eleven planetary nebulæ. Particular attention is paid to the behavior of the line λ 4686 and certain others. It is found that the occurrence of these lines is more or less restricted to the center or nucleus in some nebulae. This fact is made the basis of a proposed system for the classification of nebulæ by means of their spectra. At one extreme of the suggested arrangement are the nebulæ in which λ 4686 is coextensive with the other radiations, in the inter-

mediate classes this line is of somewhat restricted occurrence, while at the other end, or extreme, are objects in which this and certain other lines are localized in the nucleus as broad bands.

After arranging the nebulae according to the proposed system it is found that there are certain progressions in the relative intensities of the principal nebular lines as we pass from one extreme of the classification to the other, which confirms, in a sense, the general validity of the system and provides, as well, a ready means of classifying nebulæ in which the degree of concentration of the line λ 4686 can not readily be observed.

Attention is drawn to the character of the spectra of the nebular nuclei. Of the nine nuclei observed two are so faint that it is not possible to decide definitely as to the character of their spectra. The other seven are Class O stars. The close relation of stars of this class to the nebulæ is therefore strongly indicated,

Certain nebular lines correspond closely in position with lines prominent in Class B stars. Among these may be mentioned those at λ 4097.6 and λ 4267.3, and it appears probable that these lines have an identical chemical origin in both stars and nebulæ. As occurring in the stars, these lines have been ascribed to nitrogen and carbon respectively.

THE MEAN DISTANCE OF THE STARS WHOSE RADIAL VELOCITY, PROPER MOTIONS, AND PARALLAXES HAVE BEEN DETERMINED.

By Reynold K. Young.

The investigation was undertaken to answer the question, will the mean distance of the stars as determined from their proper motions and radial velocities agree with the mean distance as formed from the directly measured parallaxes?

One hundred and ninety-five stars whose parallaxes, radial velocities, and proper motions were known, were discussed with this purpose, of which, however, twenty-eight were rejected on account of having unusually high radial velocities, over fifty kilometers per second. A solution for the Sun's motion from the remaining one hundred and sixty-seven stars gave its direction as toward $\alpha = 270°$, $\delta = +14°.7$, velocity $= -17.7$ km. The average radial velocity when corrected for the Sun's motion from these values is 15.2 km per sec. The computed mean parallax of these one hundred and sixty-seven stars is $0''.106$. The mean observed parallax for the same stars is $0''.072$. If twelve stars whose proper motions are abnormally large be rejected, the computed mean parallax is $0''.085$ as opposed to $0''.060$ observed.

The parallaxes were also discussed with regard to the v as well as the τ components with similar results. The question of the effect of star streaming on these results was discussed and reasons for the discrepancy between the computed and observed parallaxes considered.

REPORTS OF COMMITTEES

REPORT OF THE COMMITTEE ON METEORS.

By Cleveland Abbe, Chairman.

I have the honor to report that during the year 1914-1915 the importance of the study of meteors has become still more seriously impressed upon us. We have also realized more than ever the great advantages that must result from the application of more accurate methods of observation and photographic record.

The manufacture of a Photographic Meteor-graph, as devised by myself and submitted to the Research Laboratory of the Eastman Kodak Company in Rochester, New York, was followed by the suggestion of a less desirable but simpler form for the general use of those interested in the subject. Having no funds at my disposal, and finding that the Weather Bureau, as well as scientific societies, do not encourage this important work, I have earnestly requested the Kodak Company to construct a few copies and put them on the market, so that the world may realize the importance of the work, which has a profound relation to the Earth's atmosphere, the gases, and the absorption phenomena that take place in its upper strata.

It is not likely that I shall be able to contribute much more to this study, but I hope that the Astronomical Society will stimulate some abler member to devote himself to this important branch of Astro-Meteorological and Physical study.

REPORT OF THE COMMITTEE ON PHOTOGRAPHIC ASTROMETRY.

By Frank Schlesinger, Chairman.

The Chairman of the Committee reported that satisfactory progress had been made since the previous report on the photographic catalog of equatorial stars derived from plates obtained by means of the doublet. All the plates have now been secured and measured and the reductions are well advanced. The uninterrupted work of a single computer for one year would probably finish the catalog, which should accordingly be ready for publication in the fall of 1916. It is probable

that this work will be extended to include nearly all of the northern sky and will constitute a duplication of Part I of the Astronomische Gesellschaft Catalog.

REPORT OF THE COMET COMMITTEE.

By George C. Comstock, Chairman.

At the Atlanta meeting. December 1913, the Comet Committee reported that the results of its work were in the hands of the printer and that it had been assured of their prompt publication. A similar statement was made at the Evanston meeting. During the nineteen months that have elapsed since the Atlanta meeting, the printer has been unremitting in assurances of immediate publication and your committee continues to believe that the volume will appear at some time.* It requests that the Committee be continued for the purpose of completing publication with expectation of making its final financial report at the next meeting of the Society.

REPORT OF THE COMMITTEE ON ASTEROIDS.

By Ernest W. Brown, Chairman.

The only work that the Committee might do effectually must be in coöperation with European workers. The war has, of course, put an end to everything of this kind for the present. We must wait for some time in the future before we can go further.

SIRIUS.

The evening Dog-Star reigns—supernal gem!
O'er Canis Major like a diadem,
Unrivalled, regal in his blaze of light,
A king supreme among the suns of night;
Frost's rigid spell rests over glade and glen,
A wintry cloak enshrouds the haunts of men,
Earth sleeps once more, a new-year's morn is nigh,
And Sirius—enthroned—adorns the sky!

Charles Nevers Holmes,
Templeton, Mass.

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* Since this report was read the complete printed report of the committee has been received and distributed.

REPORT ON MARS, No. 12.

WILLIAM H. PICKERING.

In order to study the color changes on Mars to better advantage than heretofore, a color scale has been prepared and tested during the past few weeks. It consists of fourteen divisions which have been colored and numbered provisionally as follows:— 1 is clear sky blue, 2 and 3 are fainter, while 4 is a very pale blue, 5 and 6 are light grey and light green and have been but little used hitherto. 7 is white, 8 is pale yellow, 9 and 10 are darker, the latter resembling the rind of a lemon, 11 is yellow ochre, 12 resembles an orange, 13 has a little more red with it and 14 is a clear light red. The importance, as previously noted, of having the planet and the illuminated paper of the same brightness when estimates of color are made, is shown by the fact that the nearer we bring the light to the scale, the yellower the paper appears. The light employed was a 2 c.p. tungsten lamp shining through the standard blue glass.

TABLE I

COLOR OF THE DESERT REGIONS.

Date	Carbon	Tungsten	Blue
Oct. 2	—	8	14
9	—	9	13, 14+
15	6	10	12
17	10	—	—

The color observations made during the month by means of this scale are given in Table I. The scale was not completed until October 12, so that the observations of the two earlier dates had to be reduced to it from a comparison with previous individual color sketches. The observations with the blue glass are somewhat conflicting, and are more subject to error than the others, because I have not yet been able to secure a torch capable of carrying a sufficiently high candle power tungsten light to produce equality of illumination. They are given now however with the others notwithstanding this fact, since observations made during this month were of particular interest, because as stated in our last Report it was expected that the Martian skies would begin to clear about the middle of October, the vernal equinox on Mars, and that thereafter the planetary markings would become

more distinct. The increasing redness of the desert regions, as indicated by the observations made with the carbon and tungsten lamps, is shown by the higher scale readings towards the end of the month. That is to say, the Martian haze did clear away, showing the true color of the desert regions of the planet. The same fact is also brought out in another way by the increasing clearness with which the canals and lakes appeared, in spite of the fact that the angular diameter of the planet increased during the observations only from 6″.1 to 6″.8.

The northern snow cap appeared white throughout the month, indicating freedom from cloud in that region. When the light is reduced however, either by thin cirrus cloud in our atmosphere or by a deposition of dew on the lens, the snow cap turns yellow, and may then appear of the same color as the clouds, which at this season constantly envelope the southern pole. Indeed this discoloration of the snow is usually the first sign of dew on the lens.

As expected, the northern snow cap reached its maximum size the latter part of September, the Martian date occurring in the sixth week of February, as was also the case at the previous opposition. It will be remembered that eight weeks make a month on Mars (Report No. 10). This seems to have been a somewhat colder season on the planet than the previous one, since the snow reached to a lower latitude during most of the month by 3°.5 or 130 miles (210 km). The lowest latitude reached and maintained was 51°.5 or about that of Greenwich.

TABLE II

DATA OF OBSERVATIONS.

No.	1915	⊙	M. D.	Long.	Lat.	Sun	Diam.	Seeing
		°		°	°	°	″	
1	Oct. 2	352.0	Feb. 41	61	+12	−3	6.1	10, 8
2	" 5	353.5	" 44	29	+13	"	"	8, 7
3	" 9	355.5	" 48	356	+14	−2	6.3	12
4	" 14	358.0	" 53	328	"	−1	6.5	6, 5
5	" 15	358.4	" "	294	+15	"	"	6
6	" 17	359.4	" 55	279	"	0	6.6	6
7	" 18	359.9	" 56	271	"	"	"	7
8	" 19	0.4	Mar. 1	258	"	"	6.7	10
9	" "	"	" "	266	"	"	"	10
10	" 22	1.9	" 4	228	+16	+1	"	10
11	" "	"	" "	253	"	"	"	9
12	" 23	2.4	" 5	223	"	"	6.8	10
13	" "	"	" "	236	"	"	"	11
14	" "	"	" "	246	"	"	"	10
15	" 27	4.3	" 9	158	"	+2	6.9	6

Fifteen observations of Mars were secured during October, the data of which are arranged as in previous Reports and are given in Table II.

When any of the large polar marshes, but especially Acidalium, come around the sunrise limb, they are usually followed at a distance, sometimes as great as 200 miles, by a yellow or white area of considerable size. The former color indicates cloud, and is the commoner of the two. The white probably indicates a thin layer of new fallen snow. It must be thin, since it never persists to the central meridian. On October 9, Martian date February 48, a pure white area one-third the size of the polar cap and of the same whiteness and brilliancy, following the Acidalium marsh, stretched from the sunrise limb to within 45° of the central meridian. It must have been an unusually heavy fall for Mars, for this would indicate that it persisted until nearly 11 o'clock in the Martian morning. Its size was rather difficult to determine for, unlike the snow cap, it had no sharply defined southern boundary. It stretched about 600 miles south from the polar cap, or through some 16°, to latitude +37°, and must have covered nearly a million square miles of surface in the visible hemisphere, and very likely much more on the other side of the planet.

On October 18 it was recorded that the limb was no brighter than the surface of the planet just following the Syrtis. This would have been near the central meridian, and indicates that there were no clouds on the limb at that time. That clouds are much more frequent and conspicuous on the limb than on the terminator has often been noted, and rightly ascribed to the foreshortening of the surface of the planet near the limb. How great this foreshortening really is, is perhaps not generally appreciated. On October 23 at $16^h\ 30^m$ the Syrtis was invisible. Ten minutes later it was first detected as a narrow dark line very close to the limb, and separated from it by a narrow bright band of haze. Yet at this time the Syrtis was only 60° from the central meridian, and the breadth of the narrow band of haze measured one-eighth of the radius of the planet, or 0″.4. That is, all the haze existing in 30° of longitude near the equator, or 1100 miles of atmosphere, was concentrated in this narrow band. It is no wonder that a very little haze becomes conspicuous under such circumstances,—the wonder is rather that the limb should ever appear clear at all. On the other hand, on this same date an area fully 1″.5 or 1000 miles (1600 km) in breadth, of very thin light haze bounded the terminator south of Cerberus. It could just be clearly seen, its brightness being recorded as 5.5 while the region north of Cerberus at the same distance from the terminator was marked 5. This observation indicates to us both the thinness of the Martian cloud, and the explanation of why it is so seldom detected on the terminator, even when we know that it ought to be there.

It does not necessarily follow that the haze or cloud is continuous—the same effect would be produced by a large number of little isolated cloudlets. It might be a matter of interest to obtain observations whenever practicable of the times of appearance and disappearance of the Syrtis when near the limb and terminator, during different portions of the Martian year, as an indication of the freedom from haze of its atmosphere. We might thus determine if it ever became visible within 5° or 10° of the limb. On account of its shape, and position on the equator, the Syrtis is better adapted to this investigation than any other marking on the planet.

This same appearance of cloud on the terminator is indicated in a report and drawing just received from one of our associates, Professor Lau. He indicates a region extending some 2500 miles (4000 km) along the southern terminator, with a maximum breadth of 600 miles (1000 km), which he describes as a "faint bluish white region." His observation was made September 28. The writer observed the same region, similarly situated, four days later, but no trace of the bright area was detected. In its place were the usual dark southern maria of the planet. These records of faint terminator clouds visible shortly before sunset in the southern hemisphere, and appearing just at the time, and just after, the northern snow cap reached its maximum size, are interesting indications of the speed with which the water vapor is transferred from pole to pole at this season of the Martian year through the planet's atmosphere, by means of the Martian winds. Professor Lau's cloud was from three to five thousand miles south of the southern boundary of the snow cap.

It seems quite possible that a considerable portion of the water of the planet is kept in circulation, by this natural means of transportation, just as it is upon the earth. At the same time the clouds on Mars are obviously far less dense and less numerous, and consequently far less efficient as water carriers than those of our planet. It is possible to understand therefore why some auxiliary system of circulation might have been evolved to increase the fertility of the land. Now oddly enough something rather different from the ordinary canals has been recorded, which seems to serve this very purpose, just at the time when the polar cap is melting most rapidly. This we shall now describe.

The polar band, or canal bounding the snow cap on the south, made its first appearance in 1913, on the Martian date January 53. This year it was first seen M. D. February 5. The band is often of irregular width, and in the majority of cases, 38 to 7 at the last opposition, is darker on the eastern side of the disk than on the western. In 24 cases there was no choice. This difference is especially marked during the latter part of the Martian February, when the cap reaches into the

lower latitudes, and is melting most rapidly. The irregularity of shape indicates that as the planet revolves from west to east, and as the day wears on, the band grows both darker and wider. During this year's observations, on October 22 and 23, it was thought that the canal could actually be seen to have increased in size in the region to the east of the Syrtis, between the early and later observations. While it is believed that most of the narrow and comparatively permanent canals are due to vegetation, it is fairly certain that this one at least owes its appearance to the existence of marshy land or moistened or thawing soil. It reached its maximum breadth, 800 miles, east of Acidalium on October 9, M. D. February 48. It was only 300 miles in width in the same place four days earlier. The band was again 800 miles in width, this time to the east of the Syrtis, on October 18, M. D. February 56. The next day it was reduced to 500 miles, and three days later for a time practically disappeared. The following day it was again visible in the same place, with a breadth of 150 miles.

In our last report we described and figured a broad dark band running nearly north and south, and connecting the polar band with the southern maria. It differed from the ordinary canal both in the short duration of its visibility, and in the fact that while it was but a few hundred miles in breadth when first seen, it rapidly increased in size, and before it had faded out was at least 1200 miles in width, its length and breadth being about equal. It started near the Ganges, but travelled slowly easterly to lower longitudes, and when it finally faded away was situated between Margaritifer and Sabaeus. A second straight north and south hazy band 300 miles in width connected the polar cap with the Syrtis in early September and late October of this year, and doubtless was a continuous phenomenon.

The polar band is narrowest where following, that is to the west of, the north and south bands, as if they drained it of its moisture. Or perhaps we should more properly say, the bands start from the western end of the marshes, and are fed by the winds, by the evaporation from the moist regions to the northeast of them. That is to say they intercept in some manner the northeasterly moisture-bearing winds. Indeed it is pretty clear that these bands are the indication and mark left by the auxiliary mechanism, whatever it may be, which transports the water from the northern polar cap to the southern maria. Apparently the duration of their activity is very brief,—only a few weeks,—and is confined to the time when the snow is melting most rapidly.

Their straightness and directness, leading to the nearest portions of the maria, leaves a strong impression on the mind of their artificial character. They seem to be of the same nature as the bands bounding the snow, which cannot be due to vegetation, owing to their rapid

changes. Moreover they never turn green like the maria. If the north and south bands were due to irrigating ditches therefore, they would have to be the ditches themselves, not merely vegetation growing on their banks. But this is impossible, on account of their size and gradual shifting of position. The only possible explanation for them seems to be that they are soil, moistened by precipitation at night from the atmosphere.

This moisture, having reached a lower latitude, is perhaps again evaporated the next day, and transported directly to the maria. If the bands were due to natural currents of air and water vapor, they would surely be inclined to the meridians like our trade winds. Since they are not so inclined, or rather are only slightly so, through a slowly shifting angle, first east then west, they cannot be due merely to natural causes, but must, it would seem, be due to such causess haped and guided in some manner by intelligence. Whichever of the two explanations we adopt, we seem to be driven back to intelligent direction. There really seems to be no other explanation for them, with the information at present at our disposal.

On November 26, 1913, M. D. February 51, in the same region where the straight band took its origin, that is from the Acidalium marsh, a faint narrow line was seen extending 20° to the west of north, until latitude +20° was reached. It then turned sharply to 20° towards the east, and ended in Auroræ Sinus. Two days later it was much broader, but did not extend beyond the location of Lunae Lacus in latitude +20°. Two days later yet, M.D. February 55, and again February 56, it was seen as a continuous curved band joining Acidalium with Aurora. This curved band was clearly seen in its entirety this year by Professor Lau on September 28, M. D. February 37, and he also detected Lunae Lacus, which was not visible until several months later in the previous opposition. Four days after his observation the region became visible in Jamaica as previously mentioned, and his drawing was fully confirmed. He therefore saw the curved band complete this year eighteen Martian days before it had been seen to form at the previous opposition.

On October 5, M.D. February 44, the southern maria in longitude 30° were first suspected of showing a greenish tint as compared with those at the north. Four days later the color was clearly developed. On September 14 and again October 2 they had been recorded as grey. In 1913 the first greens appeared on M. D. February 44 on the same date as this year, none being visible ten days earlier. On October 23 of this year the maria were described as distinctly green.

On October 5, the Acidalium marsh was central, well developed, and dark. It reached one-third way across the disk to latitude +32°. Its

color was dark grey, but a bluish tint was suspected. The conditions were too unfavorable however to render this certain. It had appeared fully developed three days earlier. On October 9 it again appeared bluish, but it was too small to judge with certainty of its color, the corrected diameter of the disk being only 6″.3. It was tested for polarization, but none could be detected. On October 27 a large dark polar marsh was noted near longitude 158°. It evidently corresponded to the twin bays, Propontis and Castorius, of the last opposition, but our sky was too cloudy to make trustworthy observations possible.

On October 18, M. D. February 56, the Syrtis was central. It was certainly not green, but looked greyish brown. On the other hand the western portion of the southern maria was greenish grey. This was their autumn. It may be remembered that at the last opposition we noted that the greens appeared in the autumn, but were not conspicuous in the spring time. There was no indication of the marsh often seen at the extreme northern end of the Syrtis, latitude +15°. Several times Thoth was suspected, but if visible it must have been extremely faint. The next night it was practically certain that Thoth was developing, but it was still near the limit of visibility. A dark point in the end of the Syrtis was suspected, but there was much trouble from dew on the lens, rendering observation difficult. Cloudy weather intervened, but October 22 was clear, and Thoth appeared fully developed and darker than the Syrtis. The latter however was near the limb. For this reason it was impossible to form any certain opinion regarding the existence of the Syrtis marsh, still a small spot was again suspected. There was more trouble from dew. October 23 was clear and dry, seeing 10 and 11. Thoth was conspicuously visible, and although the Syrtis was near the limb, the marsh was now well developed, and darker than any other portion of the disk save Boreosyrtis. The latter was clearly grey, the former probably blue. This was the first appearance of the marsh this year on Mars, and if any observers of the planet are working to the west of Jamaica, they will doubtless be able to tell us more about it. It will not again be seen here until the latter part of November. Cerberus was seen October 22, and again the following night. It and Thoth were the first canals, excepting those associated with the polar cap, to be visible this year; diameter of the planet 6″.7. Nuba Lacus (Jarry-Desloges) was also seen October 23, and the canal Marsyas (J. D.) suspected. The first lake visible was Lunae Lacus on October 2. A minute lake was also seen in the position of the forked bay of Sabaeus October 9.

To make more readily comparable the advance of the seasons on Mars during the present and the past oppositions, Table III has been prepared. The eleven phenomena considered are the first appearance

of the polar, the north and south and the curved bands, the first appearance with a sharply defined southern boundary of the Acidalium marsh, the time when the polar cap attained its maximum size, the first appearance of a green coloration in the southern maria, the time when the polar band attained its maximum breadth to the east of Acidalium, the last appearance of the north and south band, and the first appearance of the Syrtis marsh, of Thoth and of Cerberus. Two dates are given in the third and fifth columns. For phenomena 1, 2, 3, 4, 6, 9, 10 and 11 the second date indicates the first appearance, and the first date the last observation when the phenomena in question might have been seen, but was not detected. For the fifth and seventh phenomena the two dates are selected from the whole series of observations as being the two between which the maximum probably occurred. The eighth case, unlike all the others, is a disappearance, and the first figure therefore gives the last date when it was visible, and the second the first date when it was not seen. The fourth and sixth columns give the means of these dates and their deviations. Those dates which it was possible to determine with some accuracy, and in which especial confidence is placed, are printed in heavy faced type. The last column gives the second mean minus the first. From it we see that in some respects the present season is earlier than the last, and in some ways it is later. In the case of special markings such as the Syrtis marsh and Thoth, the deviation sometimes exceeds a Martian month, but for general phenomena, such as the maximum of the snow, the appearance of the polar and north and south bands, and the green areas, the deviations are much less. In both cases the seasons this year seem to be a trifle late, for the general phenomena about nine days, for the special about 20.

TABLE III.

Relative Advance of the Seasons.

No.	Phenomena	1913	Mean	1915	Mean	'15—'13
1	Polar band	Jan. 39, 53	46± 7	Feb. —, 5	5	+15
2	N. and S. band	" 36, 40	**38**± 2	" —, 5	5	+23
3	Curved band	Feb. 53, 55	**54**± 1	" 5, 41	23±18	−31
4	Acidalium marsh	" 53, 55	**54**± 1	" 5, 41	23±18	−31
5	Snow max.	" 28, 55	42±13	" 17, 48	32±16	−10
6	Green areas	" 34, 44	**39**± 5	" 41, 44	**43**± 1	+ 4
7	Polar band, max.	" 15, 27	21± 6	" 48, 53	50± 2	+29
8	N. and S. band, dis.	Mar. 3, 4	3± 1	" 53 —	53	− 6
9	Syrtis marsh	Jan. 17, 53	35±18	" 56 Mar. 1	**1**± 0	+60
10	Thoth	" 17, 53	35±18	Mar. 1, 3	**2**± 1	+62
11	Cerberus	Feb. 8, 34	21±13	" 1, 4	3± 1	+38

The first two phenomena occurred so early in the season that the earlier limit could not be well determined at this opposition, but we may draw the following conclusions from the remaining data:—

(*a*) The curved band was certainly invisible February 53, in 1913. This year it had already clearly appeared by February 41, or twelve days earlier. As we have already seen, it was detected by Professor Lau four days earlier still.

(*b*) The southern boundary of the Acidalium marsh was not clearly defined formerly on February 53. This year it was certainly sharp, February 41, or twelve days earlier.

(*c*) The maximum of the snow and the green areas appeared nearly together, and at about the same time both years. An examination of all the observations of the snow would make it appear that in both years the maximum occurred about February 37 $\pm$10 days.

(*d*) The date of maximum of the polar band probably depends on Martian local conditions, especially temperature, since it changes its breadth very rapidly.

(*e*) The date of disappearance of the north and south band is a rather indefinite quantity, since it fades out very gradually.

(*f*) The appearance of the Syrtis marsh, of Thoth, and of Cerberus can be determined with considerable accuracy, that is within a day or two, but are clearly liable to great variations in different years, depending on Martian conditions independent of the seasons, and of which we now have no knowledge.

During the last opposition there is evidence that the Syrtis marsh appeared three times, reaching a maximum size near the Martian dates January 53, March 10 and March 47. It was not visible on the dates January 17, February 28, April 28, May 6, May 43, nor June 17. Its first appearance at both oppositions coincided closely with the appearance of Thoth.

None of the finer detail was detected this year before October 2, M. D. February 41. Since then however the canals and lakes have begun to come out as follows. The six sections of the planet have been indicated by capital letters as in Report No. 8.

October 2. **B** Lunae Lacus.
October 5. **A** Acidalium marsh, Margaritifer.
October 9. **A** Deuteronilus, Callirrhoe, Lake in Sabaeus at forked bay.
October 22. **E** Cerberus, Thoth, Boreosyrtis.
October 23. **E** Cerberus, Thoth, Boreosyrtis, Marsyas (J.D.), Nuba Lacus (J. D.)
October 27. **D** The twin marshes of Propontis and Castorius.

We are now at the height of our autumnal rainy season in Jamaica,

and on account of the unfavorable weather conditions it has been impossible during the past two presentations of the planet, and up to November 1, to secure any satisfactory observations when the central meridian lay between 63° and 223°. The condition of a considerable section of the surface, fully a quadrant, is therefore so far unknown. It is greatly to be hoped that somewhere else in the world accurate drawings have been secured of this region. The writer would be pleased to communicate with any such observer.

In the October number of POPULAR ASTRONOMY, Dr. Lowell questions the actuality of the shifting of the canals, and states that the appearance itself is not new, having been detected nineteen years ago at the Lowell Observatory. The appearance to which he refers is much older than that, as it was recorded by Schiaparelli in 1879, and again in 1882, for three different canals, Araxes, Laestrigon, and Titan (Flammarion 1, 333, 336, and 360). His interpretation of what Schiaparelli, as well as of what he himself saw, is very likely correct.

His claim of exceptionally good seeing at Flagstaff it is thought is well founded. The writer spent six months there when the first telescope was erected, and wishes to say that he has never seen better seeing either at Arequipa, where he spent two years, nor in Jamaica, where he has now spent five, than the best seeing at Flagstaff. Indeed there is practically no choice between the best seeing in the three places. It is his impression however that there is considerably more good seeing in Jamaica than at either of the other stations. This is perfectly natural, for not only has it a more uniform climate from day to day, with a smaller daily range of temperature, but at Flagstaff they have a long winter when the seeing is inferior, and at Arequipa a long cloudy season, which also comes during the northern winter. Although we in Jamaica are at present in the midst of one of our rainy seasons, and this has proved to be an extraordinarily wet year, with two hurricanes in our vicinity, and four days in the last three months when the rainfall ranged from six to ten inches, yet on thirteen nights out of the thirty-one in the past month, our seeing has been recorded from 10 to 12, 6 being about the best that we have in Cambridge, and 12 being perfect for an 11-inch telescope. Eight nights were completely cloudy.

Dr. Lowell's suggested explanation of what we have called shifting canals is that the apparent shifting is due to the existence of two similar canals which appear one at a time, first one and then the other, and that the second is then mistaken for the first.

In Report No. 3 it is noted that the difference in longitude between Aryn and Margaritifer according to Schiaparelli is 21°.3 while according to Lau it is 28°.1. The difference 6°.8 amounts to 250 miles, and would be about 1″. It would be almost as great as the distance between the

two branches of the forked bay of Sabaeus. Both authorities used micrometers, and it is inconceivable that the difference should be due to errors made by two such careful observers. Neither does it seem likely that a marking resembling Margaritifer or Aryn should have appeared slightly to one side of the true one, which should in the meantime have disappeared. Canals are tangent to either side of Aryn, and prolong Margaritifer. If either Aryn or Margaritifer shift, the associated canals must shift with them.

In Report No. 4 it is shown that in six weeks the southern ends of the twin bays near Propontis and Castorius shifted westerly (in a terrestrial sense) through about 10° of longitude, or some 280 miles. A glance at the figure will show that there could by no possibility be a lack of identification of the bays. The bays coincide with the two canals Brontes and Hades on Antoniadi's map (Flammarion **2**, 592).

In Report No. 7 it is shown that observations by M.G. Fournier made at the observatory of of M. Jarry-Desloges indicate a mean change in longitude of 2°.9 for sixteen clearly defined points on the surface of the planet in four months. Thirteen points moved toward the west, two toward the east and one was stationary. Aryn and Margaritifer each shifted 7° in longitude. Most of the others shifted less.

In Report No. 6 a change in Elysium is described. A few additional facts are now added. The first clear representation of it seems to have been by Lohse in 1873, who represented it as a circle 1200 to 1400 miles in diameter. In 1877 Green represents it as an ellipse measuring 750 by 1000 miles. Schiaparelli did not see its northern boundary in that year, but in 1879 represented it as an elongated pentagon measuring 750 by 1400 miles. In his map based on all of his observations up to 1886 it is shown as a regular pentagon with rounded sides, 1100 miles in diameter. In 1892 several careful drawings by Professor Douglass and the writer all show it as a circle 600 miles across. In 1903 its general shape was circular but with a strongly marked southern angle. It measured 1200 miles in a north and south direction (Mem. B.A.A. **16** Part 4, Plate IV). In 1911 it was clearly pentagonal according to Jarry-Desloges and his observers, diameter 900 miles (Observations **3** Plates XII and XX). At the last opposition it was repeatedly noted by the writer, at first with some surprise, that its southern angle had disappeared, and that it was now elliptical, slightly elongated in a direction north-east and south-west and measuring 1350 by 1200 miles. It is true that in 1884 Schiaparelli recorded all the canals surrounding it as double, the diameters of the two pentagonal circles being 1400 and 1000 miles respectively, but even admitting their duplicity, this would not account for the smaller dimensions above recorded, nor for the remarkable changes in its shape. Elysium is a

large and conspicuous object, readily seen and easily drawn. It is impossible that such difference in its size and shape could be due to errors. The only explanation available seems to be that the canals which form its boundaries shift in their places.

Other instances of shifting might be cited from Reports Nos. 5 and 8, but these are perhaps sufficient to show that Dr. Lowell's suggestion of a wrong identification of the canal will hardly explain the phenomenon in question, as described in these Reports.

Mandeville, Jamaica, B. W. I.

THE POSITION OF THE SUN IN SPACE.

WILLIAM ALBERT MASON.

For over half a century astronomers have been successfully engaged as far as our present standards permit us to judge, in more or less accurately locating in the magnificent reaches of space about us hundreds of our stellar neighbors. Not only have their distances from us rather definitely been determined, as well as their motions and speed, for they all are traveling at stupendous velocities through the interstices of space, but a large number of stars with companion suns revolving about them not only have had their orbits and periods of revolution accurately calculated, but through these factors actually have been weighed and their masses compared with that of our sun. It is not a little surprising and disappointing then, while so much is positively known about our neighbors, even to the constituent elements that make up the masses of these flaming suns, that so little has been done satisfactorily to locate our sun in its relative position in space, establishing in a positive proposition its dynamic share in the great aggregations of suns that the unaided eye so plainly sees about us. For it is inconceivable that our sun is isolated in space. The cause of the unsatisfactory progress made in the past in this special research is in part probably a psychological one. The objective study of external phenomena always is simpler and more natural than the introspective study of hidden and relative conditions. External stimuli and their projection by the mind to the sources of the sensation, with whatever objective data may determine the facts of existence of these external entities, seem a fundamental mental process.

Yet on the other hand our mental deductions of the facts of natural phenomena are not always reliable. Actual position and inherent or relative motion in space often are hard to define or assign. Even in

simpler matters than in the infinite correlation of interacting forces in the great universe of suns about us our mental processes sometimes are carried out to our confusion. No matter how many years of experience of life we may have had, we may be deceived any day and ascribe motion to the stationary car we are in instead of to the slowly moving train beside us. The ascribed sensation is as instinctive and for the time being as real to us as it is false in fact. Galileo was forced by a sense-ridden and unimaginative world to recant his true belief and declare after all that it was the sun which moved and not the earth.

It is natural then that in the contemplation of the heavens the objective study of the multitudinous suns, clusters, nebulae and all the infinite variety of detail that make up our celestial environment, should precede the more subjective and abstruse study of the place of our own small unit in this vast aggregation of stars. Indeed, it necessarily must be so to arrive at reliable conclusions. From the critical observation and investigation of these distant bodies and the forces that control them we must secure the facts upon which to base such a study. We must travel in our celestial journey from sun to sun, establishing facts of distance, speed, movements—individual and collective—the clustering and gravitational attractions as evidenced in star clusters and star streams, and then return to our sun with all this correlated information to discover in what way it is influenced by the cosmic movements of the congeries of suns about it. We should bear in mind, however, despite the inability of the mind always to understand and interpret appearances, that what the eye really sees is the fundamental criterion, and when checked up by collateral facts is superior to all theoretical hypotheses that do not square with visual facts. Hypotheses in regard to celestial bodies have been promulgated, accepted, rejected and recanted by the score because they have not been corroborated by observed phenomena or because they run counter to them. A single illustration will explain the enormous difficulties of the astronomer, who has to build up the plan of the entire universe from appearances only. Sir John Herschel in "Outlines of Astronomy" refers to the speculations of Mädler in which he assigns the constellation of the Pleiades as the center of the universe around which the sun and stars revolve as "a situation in itself utterly improbable, lying as it does no less than 26° out of the plane of the galactic circle, out of which plane it is almost inconceivable that any *general* circulation can take place." Mädler's theory certainly is fantastic, and with the exception of Andre probably no great astronomer has accepted it. But there is nothing whatever to militate against the proposition that the Pleiades may not be approximately in the middle of the stratum of the Milky Way. They apparently

are 26° south of the medial line; but our sun, as we shall undertake to prove, is a certain distance out, probably a greater distance, on the other side, the north side; and as the Pleiades are not so very far away in space, as stellar distances run, their parallax being about 0″.013, or 250 light years, our visual ray projects them divergingly upon the celestial vault an ever increasing distance. Of course this is a perspective exaggeration which the astronomer must take into account.

In essaying to locate the sun in its proper position among the stars, the most casual observation of the starry vault on any clear night reveals the most obvious and striking fact of the existence of a mighty ring of stars completely surrounding the earth, countless in number, but probably greatly exceeding one hundred millions of suns. This ring is continuous and uninterrupted and, though divided in places and everywhere irregular and varied, the medial line is remarkably regular. There are other bodies in the heavens that somewhat resemble this galaxy of stars, but all of them are exceedingly small, most of them being telescopic. The ring nebula in Lyra as seen in a small telescope is nearly round, but as it is only a few seconds in diameter it is invisible to the naked eye. The great nebula in Andromeda, which is 2½° in diameter and plainly visible to sharp eyes, may be in reality round, but it lies nearly edgewise to our line of sight and appears as a greatly flattened and foreshortened ellipse.

Obviously the sun cannot belong to either of these telescopic systems or to others like them, they appear so remote. However grand the real scale of their magnitudes, the very fact that they do not surround us shows that we are no part of them, though they may be members of our stellar universe and there is every reason to believe they are, in common with every celestial object within our ken. But it is a very different proposition when we come to consider our relation to the Milky Way. Here is a grand aggregation of stars, condensed in a narrow band varying from five to thirty degrees in width, vastly outnumbering the sum of all the stars seen anywhere else in the heavens, that completely encircles the sun throughout the entire vault of the sky. It is a visual fact concerning which there can be no mistake. Undoubtedly we belong to a system of suns that rings us in in every direction we may look, throughout its entire circuit of the heavens. This question may be decided almost without argument. The thing that we are in we belong to. It may be conceivable that we have been caught in the act of diving through the ring, as some astronomers believe that 1830 Groombridge is doing, with its speed of 200 miles per second, carrying it through our system at the rate of 6,307,200,000 miles a year. But this whimsical assumption in regard to our sun may

be dismissed at once as entirely untenable, as the sun's path is not at right angles to the plane of the Milky Way but is nearly parallel with it.

Assuming then the fact to be incontestable that our sun is a member of the galaxy or at least is within it, the next question to be solved is its location in the galaxy. In the first place is it in the ring proper, if the galactic system be a ring, or is it in the vast interspace? It may not affect the question in the least to be reminded that we are not at all sure yet that what the eye takes to be a distant ring may not in reality be the projected effect of a very complex system of curved, perhaps spiral, clouds and streams of suns lying in the flat plane of the Milky Way and making up its interior and seen densely projected in the line of its plane as a ring. Sir William Herschel, probably the greatest astronomer that ever lived, advocated such a flat disk, of stars rather uniformly distributed and of vast extent but of comparatively limited thickness; our position being nearly central in the disk, seeing the stars very much diffused toward the poles of the galaxy and greatly condensed through all its radii towards its great circle in the heavens. Later he modified his belief in an even distribution of stars within the disk and admitted the existence of enormously condensed masses and clusters of stars. Sir John Herschel in describing the Milky Way writes: "The earth occupies a place somewhere about the middle of its thickness, and near the point where it subdivides into two principal laminæ inclined at a small angle to each other." This point would be by his own description at γ Cygni, in 40° north latitude; a star by the way with a parallax of 0″.106. In another place commenting on the excessive brightness of the stars in the southern reaches of the Galaxy he writes: "It conveys strongly the impression of greater proximity, and would lead to the belief that our situation as spectators is separated on all sides by a considerable interval from the dense body of stars composing the Galaxy, which in this view of the subject would come to be considered as a flat ring or some other re-entering form of immense and irregular breadth and thickness, within which we are eccentrically situated, nearer to the southern than to the northern part of its circuit." These two statements seem contradictory. They certainly are very hard to reconcile. We shall have to accept the one that is upheld by the preponderance of facts. Again in commenting on the undoubted fact that there are in nearly all parts of the southern hemisphere more stars to the square degree than in corresponding parts of the northern skies, Herschel says: "It may, and not improbably does, arise from our situation not being precisely in the middle of its thickness (the Milky Way), but somewhat nearer to its northern surface." According to Sir John

Herschel then, the sun is situated in the great interspace of the Milky Way in its central plane, but eccentrically placed to the south of the center and near the northern limit of thickness of the vast galactic disk or ring, causing us by reason of our outward position to see more stars through the ring southwards than northwards. Chapman and Mellotte's recently published charts giving the number of stars to the seventeenth magnitude in each square of fifteen degrees show that there are from two to four or more times as many stars in corresponding regions in the southern heavens as in the northern skies.

I believe all astronomers agree with Herschel in his theory regarding the northward position of the sun in the stratum of the Galaxy; but is the great astronomer correct in placing the sun nearer the southern circuit of the Milky Way? Before this question can be intelligently answered it is essential that we ascertain beyond a doubt the true shape of the Milky Way. If it is a true circle to the eye, the sun must be situated somewhere on the polar axis. If it is a great circle, the sun must be in the plane of the galaxy, but not necessarily at the center. It could be much nearer the southern or the northern confines of the ring. But these suppositional positions of the sun could not be assumed without a corresponding modification of our perspective view of the ring. At the center, unless the Milky Way is far more irregular and lacking in symmetry than such a vast cosmic, ring-like body, existent for ages and shaping under the universal law of gravitation, could be imagined to be, we should see the encircling ring somewhat alike in all directions. But if the sun were much nearer one part of the ring than another, we should expect to see a widening of the ring near us with a corresponding diffusion of the component stars, while in the opposite part of the ring we should observe a narrowing of the ring with a corresponding condensation of the stars. We know that the details of the Milky Way exhibit great variety; that there are regions rich in stars adjoining areas that are relatively barren; that there are bifurcations, streams, dense curdling masses and open vacuities. But when we contemplate the vast ring as a whole, we find it wide and diffused throughout half its circuit, spreading over Ophiuchus, Sagittarius, Aquila and Cygnus, with a maximum width of 25° to 30° and gradually diminishing in both directions throughout the southern skies until it attains a minimum width in Crux, its southermost point, of but 5°. Such varied configuration as this on such a colossal scale, seems incompatible with a stable balanced body. It is true that we observe much more irregularity in thousands of spiral nebulæ; but are they not gaseous? In the case of the Milky Way with its hundreds of millions of ponderous suns it seems reasonable to assume that, over and above the very obvious local variety exhibited throughout its great extent, any very

profound departure from a sensibly uniform shape must register a corresponding eccentric point of view of the terrestrial observer. The perspective effect of the Milky Way, wide and diffused in the northern circuit but narrow and condensed, as Chapman and Mellotte's tables show, in the southern circuit, would seem to indicate that the earth is nearer the northern than the southern part of the ring. But it must be admitted that it can hardly be four to six times as near, as the laws of optics would seem to make it; so, although the visual evidence seems to point to the eccentricity noted, there is a wide difference in favor of the claim of great local variety in the Galaxy.

This doubly eccentric position of the sun in the plane of the Galaxy, if true, should modify the generally accepted circular shape of the Milky Way. Sir John Herschel says: "It is almost a great circle", and dismisses with a foot note the contention of M. Struve that it is not a great circle by saying: "M. Struve maintains the Galactic circle to be a small, not a great, circle of the sphere. The appeal is to the eyesight. I retain my own conviction." The eye certainly is the only criterion; and the observations of astronomers recorded in their charts and sky maps are our only guides in tracing the path of the Milky Way through the heavens. Herschel himself has defined it most clearly and Proctor and others have accurately charted it. But it is not easy always to determine the medial line; yet careful measurements on any reliable sky map will show that in the twenty-fourth hour in Cassiopeia, the point of highest northing, the medial line is about 35° 30′ from the north pole, while the medial line in Crux in the twelfth hour, the point of lowest southing is only 27° 30′ from the south pole—a difference of 8°. The location of the latter point is very definite, as the Milky Way is only about 5° wide at this point; but in Cassiopeia it is 20° wide and very diffused, though it is brightest near the northern edge. It is only by taking the distance of the medial line from the south pole and comparing it with the distance of the most northerly edge of the Milky Way from the north pole that we can find any equality of conditions. These measurements, I submit, tend to confirm the belief that the galactic circuit is not quite a great circle, but that the southern stream in Crux is appreciably farther south from us while the northern stream in Cassiopeia is correspondingly nearer. Possibly it is not a circle at all, but may be slightly elliptical. The stream appears to cross the equator at almost exactly opposite points, at $6^h\ 40^m$ in Monoceros and $18^h\ 40^m$ in Aquila. This latter point, however, is very uncertain, as the great branch coming south from Cygnus terminates here on the equator, making it difficult to judge the true medial line.

Simon Newcomb in his "Positions of the Galactic and Other Principal Planes towards which the Stars tend to Crowd" has made a very careful study of the Milky Way, plotting the medial line "as fixed by eye-estimate or in the centers of the agglomerations." On this line he established 42 determining points at nearly equal distances and calculated their mean galactic latitude. If the central line were a great circle, the mean latitude of all these points should reduce to zero. The result, however, was $-1°.74$. Even with the branch in the 18th hour included, the result was $-0°.98$; showing that the Milky Way runs farther south than north. Newcomb sums up his notable investigations as follows: "It therefore appears that this stream is not, on the whole, a great circle, but has a deviation showing a well-marked displacement of our system from the central plane in the direction of the constellation Coma Berenices, in which the north galactic pole is situated." I believe every evidence of the sky points to this conclusion. It is probably confirmed on the grandest scale by the fact that there is hardly a break in the even continuity of the entire margin of the Milky Way on the southern border in Cassiopeia, the west in Monoceros, the south in Crux and the east in Aquila. That is, the entire border of the Milky Way on the side encircling its south pole practically is continuous, while in every quarter on its northern side it is irregular and broken. The meaning of this is that being out from the central plane northwards toward the pole of the Galaxy, we look tangentially over the southern or outer rim of the Milky Way, seeing a comparatively smooth contour to the ring; while on the inner rim, the one encircling the north galactic pole, we see on every hand probably the curving streams of stars leading into the diversified interior of the galaxy.

The present writer has attacked this subject from a new angle; new at least as far as his knowledge goes. Believing that any plot of our nearest neighbors that would indicate their relative positions and their recedence into space not only ought to show their grouping and trend but also indirectly to reveal the location of the outlook, such a plot was undertaken.

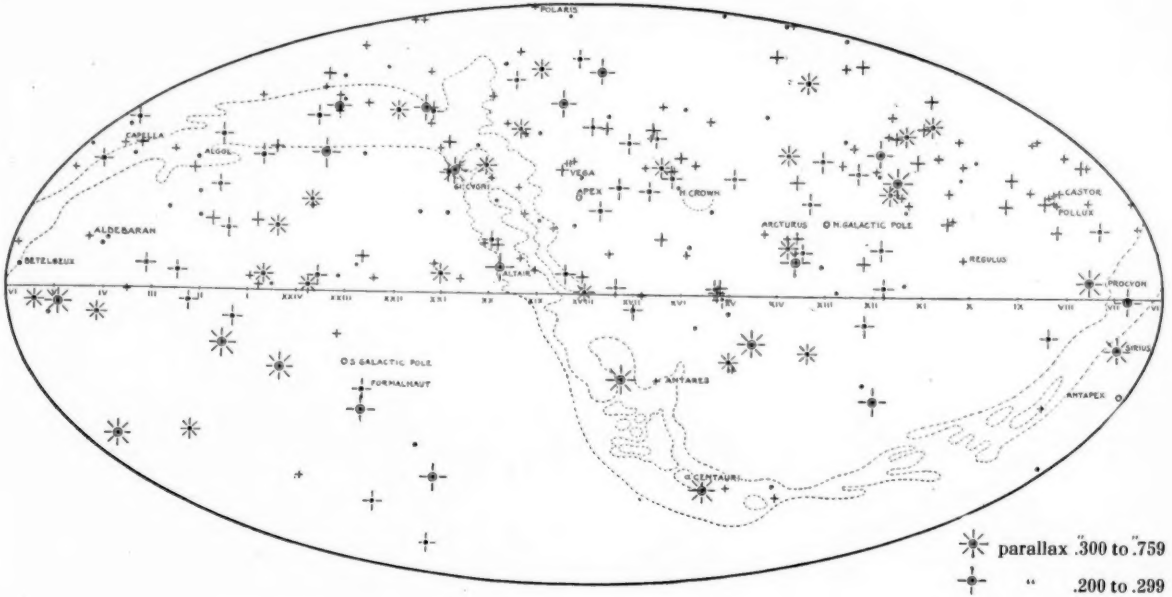
It will be necessary before describing the result to consider the ordinary laws of perspective as applied to different groupings of units. The imagination also must be appealed to in order that we may judge and test the realities of certain stellar groupings. Some astronomers speak of a solar cluster, others refer to the sun as being immersed in a star stream. Kapteyn speaks of two star streams intermingled, with all our neighboring stars belonging to one or the other, the individual members of which are traveling in almost totally opposite directions.

The preferential apex of motion of one stream, the stream that seems to be passing us, is given as $91°$ R.A., $+ 13°$ Decl. This point is a little

north and west of Procyon, on the edge of the Milky Way; the ant-apex of the sun being near by, diagonally across the Milky Way through Monoceros, southwest of Sirius, but south of the Milky Way. The apex of motion of the counter current is in the opposite part of the sky. We will not here enter upon the discussion that leads Schwarzschild to believe that there is in reality but one stream, the other motion being reflex, but will consider the perspective effect of star clustering and streaming. If the sun were immersed in the middle of a globular cluster, near and far suns would be very nearly uniformly commingled in all angular directions. If it were situated near the confines of such a cluster there would be a radial distribution of suns. A very few near suns would be projected rearwards, while a larger number of near suns would be widely scattered forwards, their distances apart seeming to decrease inward toward the center of the cluster as their distance into space increases. The middle distance and farthest suns, in proportion to their distance from us would seem to crowd together toward the center of the cluster. If the cluster were prolate or any other modification of the spheroid with the sun situated in the middle or at one end of it, we should have to imagine what would be the perspective effect of the arrangement of near and far stars looking forward, backward and sideways from our assumed positions.

The plot referred to was an equal-area map of the entire sky upon which were plotted all the stars of appreciable parallax given in J. C Kapteyn's list published at Gröningen in1910, down to and including those having a parallax of 0″.020, 262 stars in all. After plotting them in their proper right ascension and declination, each star was marked with a character and color corresponding to a classified table of parallaxes with assigned symbols for the lesseningp arallaxes. The nearest stars were made the largest and given a red color; the next were made smaller but still red. The stars of the next group in order of diminishing parallax were drawn in blue and given three characters to differentiate between their declining parallaxes. Stars of the lowest classification were drawn in black and given three distinguishing characters to indicate their progressive degree of remoteness down to the parallax of 0″.020, corresponding to a distance of 163 light years.

Thus having before the eye at one glance seven different symbols indicating the stage of remoteness of every star plotted, it became a comparatively easy matter to judge and interpret the positions and clustering of these neighbors of ours as they recede into the abyss of space toward destinations unknown to us, but indicated by their significant groupings. In the first place in examining the chart, as we would expect, we find that the very nearest stars are scattered far and wide in both hemispheres. There are no apparent groupings of them,



parallax .300 to .759
" .200 to .299
" .150 to .199
" .100 to .149
" .080 to .099
" .040 to .079
" .020 to .039

CHART OF THE HEAVENS SHOWING THE LOCATION OF 262 NEAR STARS WITH SYMBOLS INDICATING THEIR PARALLAX.

nor do they seem to favor any particular part of the sky, not even the Milky Way. But the most obvious fact is that considerably more than five-sixths of all the stars plotted are north of the equator. This certainly cannot wholly be due to the fact that the southern skies have not received the searching investigation to which the northern skies have been subjected. Sirius, 16° 35′ below the equator and Procyon, 5° 29′ above it, ride high in our southern sky, well within the scope of our northern observatories; yet there have been detected in this entire quarter of the sky in which reside these two of our very nearest neighbors less than twenty parallax stars. Evidently our solar cluster or stream does not lie in this direction, though the antapex of the solar motion is in this very region.

The most striking fact in viewing this chart at once becomes obvious: The existence of a pronounced grouping of the stars, more or less circular or ring-like, around the star Vega; the nearer stars being in the outer, irregular ring, with the middle distance stars within them. The more remote stars fill up the interior space. It was a continuing surprise as more and more parallax stars fell into place in this ring about this star, until within a radius of 40° around it thirty-seven stars were included; more than one-seventh of all the stars plotted.

In a corresponding radius about Sirius only twelve parallax stars can be counted. There began to be prefigured to the expectant eye the actual solar cluster or stream stretching off into space towards the apex of the sun's path on the edge of the neighboring constellation of Hercules, in 272° R. A. and +28° Decl. But the clustering is distinctly around Vega itself, not around the solar apex, which is, however, but ten degrees distant.

While the parallax stars are rather thickly distributed about Vega in the manner described, there is a very broad zone entirely encircling them that is almost wholly devoid of near stars of any parallax; only two or three such stars being counted in the entire zone. There is another group of stars somewhat similar to the one just described, only considerably more irregular and diffused, containing more stars but scattered over a much greater area, of which the approximate center seems to be the constellation Gemini. The arrangement of stars is on the whole quite similar to the Vega group, with the nearer stars in the outside ring, here very irregular, and the more distant stars at the center in the constellations of Gemini and Lynx. This group stretches off through Auriga and Perseus, where it seems to merge with the Milky Way, still having the nearer stars outlying and the more distant ones near the middle of the cluster or stream.

Now, what is the interpretation of this peculiar grouping of near stars north of us? In the first place it is very evident that the sun is

not deeply immersed in a star cluster. If this were a fact the stars of large and small parallaxes, as we have noted, would be rather uniformly commingled in all directions, with no evident preferential perspective vertex. The more or less regular arrangement of stars around Vega, where the middle distance stars surround the more remote ones, seems to point to the sun as sensibly outlying this cluster on the south preceding side. As there is but one direction from this cluster in which the sun can possibly lie, that is toward some point on its path of motion in space from its antapex to its apex, we seem to be approaching very near the solution of our problem and to have established rather closely the actual position of the sun. But how are we to interpret the other much more scattered and irregular grouping of stars in the neighborhood of Gemini, with the almost totally bare space between them? It may be an independent cluster viewed from our position in space or it may be a continuation of the first grouping of stars beyond the zone of interruption. It seems in either case that we have another converging line of sight from the apparent perspective center of this cluster to our position on the sun's "right of way" through space. These two converging lines, visual not mathematical, from the two groups of parallax stars indubitably point to a place on the sun's path in the broad barren zone referred to, where for a space of more than fifteen degrees there is not one parallax star.

But what is the significance of this barren zone between these two clusters of stars? I believe it to be the perspective effect of the very condition of affairs that we would expect to find immediately about us if we were on the edge of a narrow stream of stars in which we might be traveling. Imagine a person walking along a narrow but extensive strip of trees. He would see the distant trees in front of him and behind him converging in perspective and apparently crowding together in the depths of the wood; but just where he has stopped to view his surroundings, on his right or his left, according as he is nearer one edge or the other of the narrow strip of woods, he would see the trees opening up and at their maximum degree of apparent scattering. From this temporary point in his journey the trees would apparently seem to be divided into two groups with an open zone between them just where he is standing. In this open zone there would be no distant trees, but only near ones, depending on the width of the strip. These are almost the identical conditions that seem to prevail in the two star groups in our northern heavens. The comparatively empty zone between them appears to be the "opening in the woods" and actually locates the traveler.

But if the sun is in a star stream as the facts seem to indicate, we would expect the stream, being on the vast scale demanded of any

finite portion of the Milky Way, the stars in whose unfathomable depths are believed to be so remote that their light extinguished would continue to shine for a thousand years, to exhibit the same perspective arrangement of stars looking directly back as looking ahead, for be it remembered the whole effect is a matter of perspective. We already have stated that there is no such configuration of stars around the sun's antapex as we see in the immediate neighborhood of its apex. The former region is practically devoid of near stars. We must, therefore, qualify in a measure the proposition that the sun is moving in a stream of stars in which "the direction of the solar movement agrees with the 'lie' of the belt", as Miss Clerke describes it. Nevertheless, this statement of this most accomplished astronomer concerning the solar stream or belt of stars is almost in line with the observed facts.

The sun appears by our chart to be situated on the southern fringe of a stream of neighboring stars just north of us and farther out from the Milky Way, the "lie" of the belt in our immediate neighborhood seeming very nearly to coincide with the thirty-fifth parallel of north latitude. This apparently is a very wide deflection both from the Milky Way and from the line of the sun's motion; but really it is not in the least incompatible with a comparatively near position of the entire stream to the central stratum of the Galaxy or to the sun's line of motion. Our near but probably eccentric position on the southern confines of the stream, somewhat farther in toward the center of the Galaxy, causes us to see the stream projected and enormously extended in perspective across the entire northern sky. This is only apparent. In estimating celestial distances we should always take into account the laws of optics. One must remember for instance that two stars of the same parallax to be at the same distance from each other that they are from the earth will lie fully sixty degrees apart on the celestial vault. This fact tends to discount our conception of celestial magnitudes. If Procyon were the same distance from us that Sirius is, instead of being one-quarter of the distance farther removed, it would lie about thirty-four and one-half degrees farther east, or within three and one-half degrees of Regulus. The solar stream while it may be most magnificent in its proportions doubtless is but a minor detail of the interior structure of the Galaxy. It is difficult to establish its relation to the whole; but it probably is a spiral branch of suns sweeping in toward the Milky Way in the general direction of Aquila, to whose great curve the sun's present path is tangent in the direction of its apex of motion.

Judged then by all the foregoing facts, the sun appears to be in that part of the heavens indicated by its line of motion from its antapex a little southwest of Sirius to its apex a little southwest of Vega. It is

located in the apparently open zone between Arcturus and the Northern Crown where the map shows that we look through the comparatively narrow stream, seeing almost no stars in the wide outlook. The sun in this position, as one may see by plotting in a celestial globe, necessarily must be much farther on in its journey through the Galaxy than the center of the Milky Way. Indeed, it must be considerably nearer Sagittarius than Monoceros, as See correctly claims; not nearer to the southern Milky Way as Herschel believed. Both Newcomb and Miss Clerke locate the sun in the direction of Coma Berenices, where the pole of the Galaxy is situated; but I believe the facts uphold the hypothesis of a considerable northern shift of eccentricity in its location in the central stratum. The sun undoubtedly is out from the plane of the Galaxy toward the north pole, as the Herschels first announced and Newcomb has so masterfully demonstrated and as celestial maps seem to prove. Struve says it is north of the central plane a distance corresponding to about the average distance of a star of the second magnitude. It seems much farther than this.

From this position then, as described in this paper, considerably out from the central plane of the Galaxy or well toward its upper limit, and considerably nearer the Milky Way in Sagittarius and Aquila than in Monoceros, we look out upon the northern heavens, away from the Galaxy, viewing even through the open zone already frequently referred to, 109,000 distant suns—mostly telescopic—in a square of fifteen degrees on a side. Farther out from the plane of the Galaxy than ourselves we also observe in the northern skies the constellations of the Northern Crown, Coma Berenices, the Great and Little Bear and all the other great constellations of the northern heavens, as well as Arcturus, Regulus, Polaris, Castor and Pollux and other neighboring suns. In the southern heavens around Fomalhaut, which is very near the south pole of the Galaxy, we look through the interior of the Milky Way, seeing at this point 500,000 distant stars—mostly telescopic—in a square of fifteen degrees on a side. Between us and the Galaxy but projected through the interior of the ring we see α Centauri, the nearest star in the heavens, Sirius, the third nearest, 61 Cygni in the first ten, Altair, Betelgeux, Aldebaran, Capella and Algol, all neighboring stars. We also see the brilliant constellations of the Pleiades, Hyades and Orion, which form a belt of brilliant stars known as "Gould's Belt," which some astronomers designate as the solar belt. If the sun does belong to this belt of stars, and it does seem to lie approximately in the great circle passing through them, Cassiopeia and Vega, it is a very great distance from that part of the belt passing through these three constellations. Omitting Sirius, which also seems to lie in the belt, there does not seem to be a star of large parallax any where in this region.

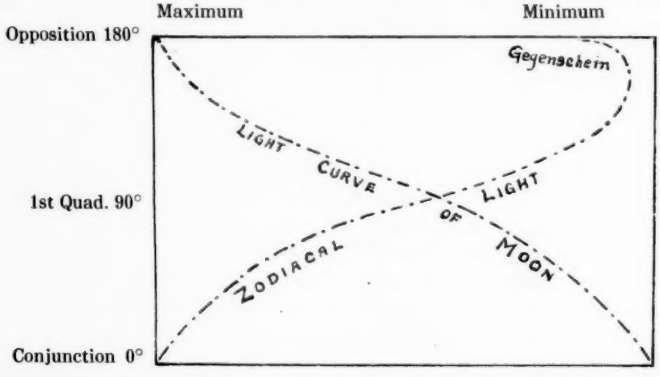
except the tiny Weisse, 592, near the nebula of Orion, until we reach the constellation of Cassiopeia with its five near stars.

The writer hesitates to assume a didactic attitude toward this phase of the problem or even in the propositions advanced in this paper. The entire question is one most difficult of solution, as it seems to present problems of unusual subtlety that must be solved more by inference than by objective study after all the facts have been deduced. Beyond a doubt after every parallax star in our part of the universe has been critically studied as to its position, distance, proper and radial motion, we eventually shall be able to state with some reasonable degree of certainty where the sun is located in the heavens with reference to his neighbors, and the part he is taking in their celestial activities.

LIGHT CURVES OF THE MOON AND THE ZODIACAL LIGHT COMPARED.

REV. W. E. GLANVILLE, Ph. D.

From the diagram it is clear that the moon's brightness as seen from the earth increases from zero at conjunction to maximum at opposition. But a distinction should be made between the Moon's apparent brightness and its intrinsic brightness. The intrinsic brightness varies inversely as the square of the Moon's distance from the sun. At con-



ILLUSTRATING DIFFERENCE BETWEEN LIGHT CURVES OF THE MOON AND THE ZODIACAL LIGHT.

junction the moon is, roughly, 480,000 miles nearer the sun than at opposition. Hence its intrinsic brightness at first quarter is *pro rata* greater than its intrinsic brightness at opposition but on account of

defect due to phase at first quarter the apparent brightness (*i.e.* as seen from the earth) is less than its apparent brightness at opposition when the illuminated hemisphere is turned squarely towards us. In other words, from new to full the light curve increases *not because the intrinsic brightness of the moon increases but because more and more of the illuminated disk is presented to our view.* Increasing brightness, as seen from the earth, therefore depends on the proportion of the disk of the moon that we see luminous. Further, the degree of illumination at any phase is also affected by the perigee and apogee points of the line of apsides—at perigee the apparent brightness will be greater than when, in the same phase, the moon is at apogee. Now suppose that instead of one moon there were a series of rings of very little moons—a shoal of meteoritic satellites giving the appearance of a continuous curve—encircling the earth and sufficiently near and so inclined to the ecliptic in their orbits as to pass within the earth's shadow. Not only would the intrinsic brightness of such a system be greater from conjunction to first quarter than from first quarter to opposition, but in addition the hemispheres unilluminated by sunlight would be illuminated (1) by earth-shine, greater or less according to distance from the earth, and (2) by light reflected from the illuminated hemispheres of neighboring members of the system. The result would be a generally continuous illumination greater near the E. and W. horizon points decreasing as earth-shine is lost and elongation from the sun increases and reaching the vanishing point as the penumbra of the earth's shadow is approached—save and except for the faint illumination discernible at the gegenschein point, due to sunlight reflected from the earth's perimeter. To observers in temperate latitudes it is an exceedingly difficult exercise of the imagination to conceive of the E. and W. zodiacal lights as forming constituent parts of a terrestrial ring system. This is due to the fact that the Zodiacal light band lies along the ecliptic and that the ecliptic seldom makes a large angle with the horizon at such latitudes. Consequently the full benefit of solar illumination of the material of the ring is not available to such observers more than 35° or 40° from the horizon points even when the ecliptic is best placed for such observations in these latitudes. In the tropics however where the ecliptic always makes a high angle with the horizon the zodiacal light appears in its most favorable aspect. Recent observations by M. Stéphanidès, Corfu, Greece, as summarized in the *Bulletin* of the Astronomical Society of France (July, 1915) are quite harmonious with the planetary ring theory of the zodiacal light. M. Stéphanidès reports that in the morning the northern border of the light is better defined than the southern; in the evening the southern boundary is more clear-cut than the northern; in winter the light is more uniform

in brightness than in autumn (or spring), when it exhibits zones of varying brightness. By means of a little reflection aided by a diagram showing the position of the earth with respect to the sun and the inclination of the earth with respect to the ecliptic in September, December and March, it will be seen that M. Stéphanidès' report agrees well with the earth ring theory of the zodiacal light—remembering always that the zodiacal light band lies along the ecliptic.

St. Peter's Rectory,
Solomons, Md., 1915, Aug. 31.

PLANET NOTES FOR JANUARY, 1916.

The sun will move northward from 23° south to 18° south during the month. It will move eastward from Sagittarius into Capricornus through a region in which there are no particularly bright stars. On January 2 the earth will be at its nearest point to the sun for the year.

The phases of the moon for this month are as follows:

New Moon	Jan.	4	at 11	P.M.	C.S.T.
First Quarter		11	" 10	P.M.	"
Full Moon		20	" 2	A.M.	"
Last Quarter		27	" 7	P.M.	"

The moon will be nearest the earth on January 4, and farthest from the earth on January 17.

Mercury will reach a point of greatest elongation east on January 20. It will then set a little more than one half hour after the sun and will therefore be visible for a few days on the western horizon just after sunset. It will set a few degrees north of the point at which the sun sets.

Venus will continue to move east and will be visible in the westen sky after sunset throughout the month.

Mars will rise about nine o'clock at the middle of January. It will still be approaching the earth and this month will come nearer to the earth than the mean distance of the earth from the sun.

Jupiter will still be conspicuous in the sky in the evening. It will cross the meridian about sunset, and will be well situated for observation and study.

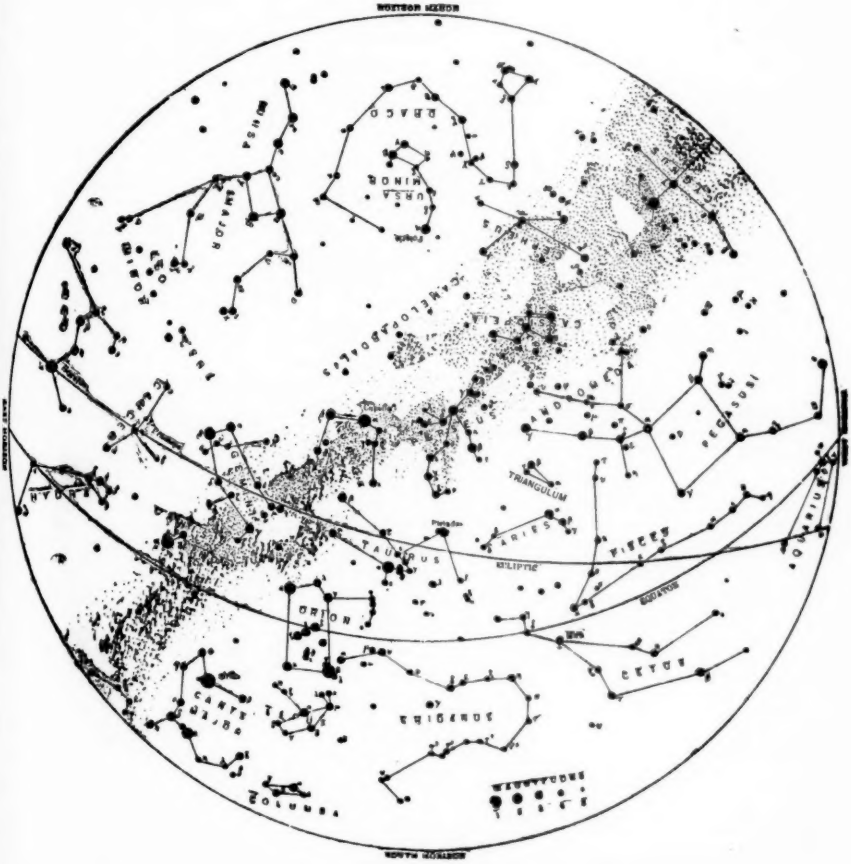
Saturn also will be conspicuous in the sky. It will rise about sunset, and may be observed in the east in the early evening.

Uranus will be a few hours east of the sun and will be within reach just after sunset.

Neptune will be in opposition with the sun on January 22. It will therefore be above the horizon practically all night during this month. It will be in the constellation Cancer.

Occultations Visible at Washington.

Date 1916	Star's Name	Magnitude	IMMERSION. Washington M.T.		Angle f'm N.	EMERSION. Washington M.T.		Angle f'm N.	Duration	
			h	m	°	h	m	°		m
Jan. 18	58 Geminorum	6.0	18	22	164	18	51	232	0	29
23	p^4 Leonis	5.7	8	36	114	9	36	299	0	59
26	87 Virginis	5.8	19	50	165	20	39	245	0	49
29	134 B Scorpii	6.4	17	53	71	18	59	313	1	6
30	*X* Sagitt. (Var.)	4.4	16	34	118	17	33	256	0	59
31	σ Sagittarii	2.1	17	21	143	17	57	213	0	36



THE CONSTELLATIONS AT 9:00 P. M. JANUARY 1.

VARIABLE STARS.

Approximate Magnitudes of Variable Stars of Long Period on Nov. 1, 1915.

[Communicated by the Director of Harvard College Observatory, Cambridge, Mass.]

Name.	R. A. 1900. h m	Decl. 1900. ° ′	Magn.	Name.	R.A. 1900 h m	Decl. 1900 ° ′	Magn.
X Androm.	0 10.8	+46 27	<13.5	T Leporis	5 0.6	−22 2	10.1
T Androm.	17.2	+26 26	10.8 *i*	V Orionis	0.8	+ 3 58	12.2
T Cassiop.	17.8	+55 14	9.9 *i*	R Aurigae	9.2	+53 28	12.8*d*
R Androm.	18.8	+38 1	12.6*d*	W Aurigae	20.1	+36 49	13.0*d*
S Ceti	19.0	− 9 53	8.1	S Aurigae	20.5	+34 4	10.0
Y Cephei	31.3	+79 48	13.0	S Orionis	24.1	− 4 46	8.2 *i*
U Cassiop.	40.8	+47 43	8.2	S Camelop.	30.2	+68 45	8.0
RW Androm.	41.9	+32 8	12.9	T Orionis	30.9	− 5 32	9.9
V Androm.	44.6	+35 6	11.0	U Aurigae	35.6	+31 59	12.0
RR Androm.	45.9	+33 50	9.5	SU Tauri	43.2	+19 2	10.0
RV Cassiop	47.1	+46 53	9.3	V Camelop.	49.4	+74 30	<13.0
W Cassiop.	49.0	+58 1	10.9*d*	U Orionis	49.9	+20 10	10.0*d*
Z Ceti	1 1.6	− 2 1	11.6*d*	Z Aurigae	53.6	+53 18	11.6
U Androm.	9.8	+40 11	12.0	X Aurigae	6 4.4	+50 15	12.8
UZ Androm.	10.4	+41 12	13.8	SS Aurigae	5.8	+47 46	<13.5
S Cassiop.	12.3	+72 5	13.0*d*	V Aurigae	16.5	+47 45	9.6
S Piscium	12.4	+ 8 24	<13.5	V Monoc.	17.7	− 2 9	11.3
U Piscium	17.7	+12 21	<13.5	U Lyncis	31.8	+59 57	12.0*d*
RZ Persei	23.6	+50 20	12.8*d*	S Lyncis	35.9	+58 0	14.0
R Piscium	25.5	+ 2 22	9.0	W Monoc.	47.5	− 7 2	10.7
RU Androm.	32.8	+38 10	10.8*d*	Y Monoc.	51.3	+11 22	10.2
Y Androm.	33.7	+38 50	10.0*d*	X Monoc.	52.4	− 8 56	8.0
X Cassiop.	49.8	+58 46	12.0*d*	R Lyncis	53.0	+55 28	13.8
U Persei	53.0	+54 20	8.6 *i*	R Geminorum	7 1.3	+22 52	7.0
S Arietis	59.3	+12 3	<14.0	V Can. Min.	1.5	+ 9 2	9.4
R Arietis	2 10.4	+24 35	10.0*d*	R Can. Min.	3.2	+10 11	9.6
W Androm.	11.2	+43 50	13.0	RR Monoc.	12.4	+ 1 17	<13.0
Z Cephei	12.8	+81 13	<14.0	V Geminorum	17.6	+13 17	10.0
o Ceti	14.3	− 3 26	7.0 *i*	S Can. Min.	27.3	+ 8 32	9.0 *i*
S Persei	15.7	+58 8	9.8	Z Puppis	28.3	−20 27	12.5*d*
R Ceti	20.9	− 0 38	<13.0	T Can. Min.	28.4	+11 58	11.0 *i*
RR Persei	21.7	+50 49	10.0*d*	U Can. Min.	35.9	+ 8 37	10.0
U Ceti	28.9	−13 35	7.5*d*	S Geminorum	37.0	+23 41	13.0
RR Cephei	29.4	+80 42	14.0	T Geminorum	43.3	+23 59	9.2
R Trianguli	31.0	+33 50	11.4*d*	U Puppis	56.1	−12 34	12.4*d*
W Persei	43.2	+56 34	9.8*d*	R Cancri	8 11.0	+12 2	11.0*d*
U Arietis	3 5.5	+14 25	<14.0	V Cancri	16.0	+17 36	12.8
X Ceti	14.3	− 1 26	9.0	RT Hydrae	24.7	− 5 59	7.8
Y Persei	20.9	+43 50	9.0	U Cancri	30.0	+19 14	9.7
R Persei	23.7	+35 20	8.8	S Hydrae	48.4	+ 3 27	10.0
Nov. Per. No. 2	24.4	+43 34	13.5*d*	T Hydrae	50.8	− 8 46	8.4
W Tauri	4 22.2	+15 49	12.3	T Cancri	51.0	+20 14	9.0
R Tauri	22.8	+ 9 56	13.5*d*	S Pyxides	9 0.7	−24 41	12.0 *i*
S Tauri	23.7	+ 9 44	<13.0	W Cancri	4.0	+25 39	12.8*d*
T Camelop.	30.4	+65 57	13.6*d*	X Hydrae	30.7	−14 15	12.5
X Camelop.	32.6	+74 56	8.2	Y Draconis	31.1	+78 18	13.0*d*
RX Tauri	32.8	+ 8 9	10.0 *i*	R Leo. Min.	39.6	+34 58	10.6 *i*
V Tauri	46.2	+17 22	<13.0	RR Hydrae	40.4	−23 34	<13.5
R Leporis	55.0	−14 57	7.8	R Leonis	42.2	+11 54	6.0

Approximate Magnitudes of Variable Stars of Long Period on Nov. 1, 1915—Continued.

Name.	R. A. 1900. h m	Decl. 1900. ° ′	Magn.	Name.	R.A. 1900. h m	Decl. 1900. ° ′	Magn.
Y Hydrae	9 46.4	−22 33	6.7	ST Sagittarii	18 55.9	−12 54	10.5*d*
V Leonis	54.5	+21 44	10.0 *i*	Z Lyrae	56.0	+34 49	13.5*d*
R Urs. Maj.	10 37.6	+69 18	11.0 *i*	RT Lyrae	57.8	+37 22	13.4
V Hydrae	46.8	−20 43	7.0	R Aquilae	19 1.6	+ 8 5	7.2*d*
W Leonis	48.4	+14 15	10.2	V Lyrae	5.2	+29 30	<14.0
S Leonis	11 5.7	+ 6 0	12.0	RW Sagittarii	8.1	−19 2	9.6
R Com. Ber.	59.1	+19 20	13.0*d*	RX Sagittarii	8.7	−18 59	10.0*d*
SU Virginis	12 0.0	+12 56	12.5	S Lyrae	9.1	+25 50	<13.5
T Urs. Maj.	31.8	+60 2	8.4*d*	RS Lyrae	9.3	+33 15	<14.0
RS Urs. Maj.	34.4	+59 2	12.5 *i*	U Draconis	9.9	+67 7	11.9 *i*
S Urs. Maj.	39.6	+61 38	10.4 *i*	W Aquilae	10.0	− 7 13	13.8*d*
T Urs. Min.	13 32.6	+73 56	10.4*d*	RY Sagittarii	10.0	−33 42	6.6
R Can. Ven.	44.6	+40 2	10.0 *i*	T Sagittarii	10.5	−17 9	10.4 *i*
U Urs. Min.	14 15.1	+67 15	9.2 *i*	R Sagittarii	10.8	−19 29	6.8
S Bootis	19.5	+54 16	9.0*d*	TZ Cygni	13.4	+50 0	10.2
R Camelop.	25.1	+84 17	10.0*d*	S Sagittarii	13.6	−19 12	11.3 *i*
V Bootis	25.7	+39 18	7.4	Z Sagittarii	13.8	−21 7	11.2*d*
R Bootis	32.8	+27 10	7.2	U Lyrae	16.6	+37 42	12.0
S Serpentis	15 17.0	+14 40	12.0*d*	TY Cygni	29.8	+28 6	13.6
S Cor. Bor.	17.3	+31 44	11.5 *i*	RT Aquilae	33.3	+11 30	13.5*d*
S Urs. Min.	33.4	+78 58	11.2*d*	R Cygni	34.1	+49 58	11.3*d*
R Cor.Bor.	44.4	+28 28	6.1	RV Aquilae	35.9	+ 9 42	10.6*d*
X Cor. Bor.	45.2	+36 35	9.4	RT Cygni	40.8	+48 32	7.8*d*
V Cor. Bor.	46.0	+39 52	9.4	TU Cygni	43.3	+48 49	9.3 *i*
Z Cor. Bor.	52.2	+29 32	<13.5	X Aquilae	46.5	+ 4 13	13.8*d*
R Herculis	16 1.7	+18 38	12.8 *i*	χ Cygni	46.7	+32 40	9.8 *i*
RU Herculis	6.0	+25 20	13.0*d*	RR Aquilae	52.4	− 2 11	10.0 *i*
W Cor. Bor.	11.8	+38 3	11.0 *i*	RS Aquilae	53.7	− 8 9	10.2 *i*
U Herculis	21.4	+19 7	11.6*d*	Z Cygni	58.6	+49 46	13.2
SS Herculis	28.0	+ 7 3	12.0 *i*	SY Aquilae	20 2.3	+12 39	12.8
R Urs. Min.	31.3	+72 28	9.0 *i*	S Cygni	3.4	+57 42	12.8 *i*
W Herculis	31.7	+37 32	13.0*d*	R Capricorni	5.7	−14 34	12.2*d*
R Draconis	32.4	+66 58	10.8*d*	S Aquilae	7.0	+15 19	9.6
S Herculis	47.4	+15 7	12.5*d*	RU Aquilae	8.0	+12 42	9.5
RV Herculis	56.8	+31 22	<14.0	W Capricorni	8.6	−22 17	12.4*d*
RT Herculis	17 6.8	+27 11	13.0*d*	RS Cygni	9.8	+38 28	7.4 *i*
Z Ophiuchi	14.5	+ 1 37	12.0*d*	Z Aquilae	9.8	− 6 27	11.2 *i*
RS Herculis	17.5	+23 1	8.6*d*	R Delphini	10.1	+ 8 47	13.0*d*
RU Ophiuchi	28.1	+ 9 30	9.0 *i*	RT Capricorni	11.3	−21 38	8.0
RS Ophiuchi	44.8	− 6 40	11.5	SX Cygni	11.6	+30 46	13.8*d*
RT Ophiuchi	51.8	+11 11	13.6	U Cygni	16.5	+47 35	8.5
T Draconis	54.8	+58 14	10.4*d*	RU Capricorni	26.7	−22 2	10.8 *i*
RY Herculis	55.4	+19 29	12.8 *i*	Z Delphini	28.1	+17 7	11.8*d*
V Draconis	56.3	+54 53	9.0 *i*	ST Cygni	29.9	+54 38	10.1 *i*
T Herculis	18 5.3	+31 0	10.8*d*	Y Delphini	36.9	+11 31	13.0*d*
W Draconis	5.4	+65 56	12.0 *i*	V Cygni	38.1	+47 47	8.6
X Draconis	6.8	+66 8	12.0*d*	S Delphini	38.5	+16 44	11.0
W Lyrae	11.5	+36 38	12.3*d*	Y Aquarii	39.2	− 5 12	<13.5
RY Ophiuchi	11.6	+ 3 40	9.8 *i*	T Delphini	40.7	+16 2	12.0*d*
SV Herculis	22.3	+24 58	9.7 *i*	W Aquarii	41.2	− 4 27	13.2
T Serpentis	23.9	+ 6 14	13.6	U Capricorni	42.6	−15 9	13.8
SV Draconis	31.2	+49 18	13.4*d*	V Delphini	43.2	+18 58	9.4
RZ Herculis	32.7	+25 58	10.0*d*	T Aquarii	44.7	− 5 31	8.6*d*
X Ophiuchi	33.6	+ 8 44	6.7	RZ Cygni	48.5	+46 59	11.0
RY Lyrae	41.2	+34 34	13.7	X Delphini	50.3	+17 16	12.4*d*
RW Lyrae	42.1	+43 32	12.2 *i*	R Vulpeculae	59.9	+23 26	10.8 *i*
R Scuti	42.2	− 5 49	5.0 *i*	TW Cygni	21 1.8	+29 0	12.2*d*
RX Lyrae	50.4	+32 42	<14.0	V Capricorni	1.8	−24 19	9.9 *i*

Approximate Magnitudes of Variable Stars of Long Period on Nov. 1, 1915—Continued.

Name.	R. A. 1900.	Decl. 1900	Magn.	Name.	R. A. 1900.	Decl. 1900	Magn.
	h m	° ′			h m	° ′	
X Capricorni	21 2.8	−21 45	<13.5	RT Aquarii	22 17.7	−22 34	10.7*d*
X Cephei	3.6	+82 40	9.8 *i*	RV Pegasi	21.0	+29 58	<13.5
Z Capricorni	5.0	−16 35	11.8*d*	S Lacertae	24.6	+39 48	10.3*d*
RS Aquarii	5.8	− 4 27	13.4	R Lacertae	38.8	+41 51	9.0 *i*
T Cephei	8.2	+68 5	7.0 *i*	S Aquarii	51.8	−20 53	9.0 *i*
R Equulei	8.4	+12 23	9.6 *i*	RW Pegasi	59.2	+14 46	13.5
RR Aquarii	9.8	− 3 19	11.3*d*	R Pegasi	23 1.6	+10 0	9.3 *i*
X Pegasi	16.3	+14 2	12.5*d*	V Cassiop.	7.4	+59 8	7.4
T Capricorni	16.5	−15 35	13.5	W Pegasi	14.8	+25 44	11.4*d*
Y Capricorni	28.9	−14 25	12.7 *i*	S Pegasi	15.5	+ 8 22	12.2*d*
S Cephei	36.5	+78 10	10.6 *i*	Z Androm.	28.8	+48 16	11.0
RU Cygni	37.3	+53 52	8.0	ST Androm.	33.8	+35 13	9.8*d*
SS Cygni	38.8	+43 8	10.4*d*	R Aquarii	38.6	−15 50	8.5*d*
RR Pegasi	40.0	+24 33	12.0*d*	Z Cassiop.	39.7	+56 2	13.6
V Pegasi	56.0	+ 5 38	<14.0	RR Cassiop.	50.7	+53 8	12.4
U Aquarii	57.9	−17 6	11.4	V Ceti	52.8	− 9 31	12.5 *i*
RT Pegasi	59.8	+34 38	11.5 *i*	R Cassiop.	53.3	+50 50	7.7 *i*
T Pegasi	22 4.0	+12 3	14.0	Z Pegasi	55.0	+25 21	9.5 *i*
Y Pegasi	6.8	+13 52	<14.0	Y Cassiop	58.2	+55 7	<13.5
RS Pegasi	7.4	+14 4	11.2	SV Androm.	59.2	+39 33	12.0*d*
X Aquarii	13.2	−21 24	10.8 *i*				

The letter *i* denotes that the light is increasing; the letter *d*, that the light is decreasing; the sign <, that the variable is fainter than the appended magnitude.

The above magnitudes have been compiled at the Harvard College Observatory from observations made by the following observers:—H. C. Bancroft, Jr., Mrs. H. C. Bancroft, Jr., T. C. H.Bouton, A. B. Burbeck, L. Campbell, H. O. Eaton, G. L. Harrell, W. P. Hoge, S. C. Hunter, J. B. Lacchini, C. B. Lindsley, O. Mach, C. Y. McAteer, C. S. Mundt, G. F. Nolte, W. T. Olcott, D. B. Pickering, C. F. Richter, F. H. Spinney H. M. Swartz, H. W. Vrooman, I. E. Woods, and A. S. Young.

Maxima of Variable Stars of Short Period.

[Calculated by Bertha Booth, and Bessie Burnham at Goodsell Observatory.]

Given to the nearest hour in Greenwich mean time. To obtain Eastern standard time subtract 5^h; Central standard time 6^h; etc.

Star	R. A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich mean times of maxima in 1916. January
	h m	° ′		d h	d h d h d h d h d h
SX Cassiop.	0 05.5	+54 20	8.6— 9.4	36 13.7	10 23
SY Cassiop.	0 09.8	+57 52	9.3— 9.9	4 1.7	3 9; 11 12; 19 16; 27 19
RR Ceti	1 27.0	+ 0 50	8.3— 9.0	0 13.3	5 6; 13 0; 20 18; 28 12
RW Cassiop.	1 30.7	+57 15	8.9—11.0	14 19.2	3 2; 17 22
V Arietis	2 09.6	+11 46	8.3— 9.0	0 23.8	6 10; 14 8; 22 7; 30 5
SU Cassiop.	2 43.0	+68 28	6.5— 7.0	1 22.8	6 13; 14 9; 22 4; 29 23
TU Persei	3 01.8	+52 49	11.4—12.2	0 14.6	2 20; 10 3; 17 10; 24 17
RW Camelop.	3 46.2	+58 21	8.2— 9.4	16 00.0	2 0; 18 0
SX Persei	4 10.2	+41 27	10.4—11.2	4 07.0	2 18; 11 7; 19 21; 28 11
SV Persei	42.8	+42 07	8.8— 9.6	11 03.1	5 21; 17 0; 28 4
RX Aurigae	4 54.5	+39 49	7.2— 8.1	11 15.0	10 8; 21 23
SX Aurigae	5 04.6	+42 02	8.0— 8.7	1 12.8	7 17; 15 8; 23 0; 30 16
SY Aurigae	05.5	+42 41	8.4— 9.5	10 03.3	11 12; 21 15; 31 19
Y Aurigae	21.5	+42 21	8.6— 9.6	3 20.6	6 13; 14 6; 22 0; 29 17
RZ Gemin.	5 56.6	+22 12	9.1—10.0	5 12.7	4 1; 9 13; 15 2; 20 15
RS Orionis	6 16.5	+14 44	8.2— 8.9	7 13.6	6 23; 14 13; 22 2; 29 16
T Monoc.	19.8	+ 7 08	5.7— 6.8	27 00.3	7 17
RZ Camelop.	23.7	+67 06	11.0—13.0	0 11.5	2 15; 9 20; 17 1; 24 6
W Gemin.	6 29.2	+15 24	6.7— 7.5	7 22.0	2 17; 10 15; 18 13; 26 11

Maxima of Variable Stars of Short Period—Continued.

Star	R.A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich mean times of maxima in 1916. January
	h m	° ′		d h	d h; d h; d h; d h
ζ Gemin.	6 58.2	+20 43	3.7— 4.3	10 03.7	2 12; 12 16; 22 19
RU Camelop.	7 10.9	+69 51	8.5— 9.8	22 06.5	8 10; 30 16
RR Gemin.	7 15.2	+31 04	10.0—11.5	0 09.5	4 15; 12 14; 20 13; 28 11
V Carinae	8 26.7	−59 47	7.4— 8.1	6 16.7	1 22; 8 14; 15 7; 22 0
T Velorum	8 34.4	−47 01	7.6— 8.5	4 15.3	5 4; 14 11; 23 17
V Velorum	9 19.2	−55 32	7.5— 8.2	4 08.9	15 15; 24 9
Z Leonis	9 46.4	+27 22	7.9— 9.6	59 0.0	30 0
RR Leonis	10 02.1	+24 29	9.1—10.1	0 10.9	7 18; 14 13; 21 8; 28 3
SU Draconis	11 32.2	+67 53	8.9— 9.6	0 15.8	3 1; 9 16; 16 6; 22 21
S Muscae	12 07.4	−69 36	6.4— 7.3	9 15.8	8 16; 18 8; 27 23
SW Draconis	12.8	+70 04	8.8— 9.6	0 13.7	8 0; 15 23; 23 23; 31 22
T Crucis	15.9	−61 44	6.8— 7.6	6 17.6	2 3; 8 21; 22 8; 29 2
R Crucis	18.1	−61 04	6.8— 7.9	5 19.8	0 21; 6 17; 18 9; 30 0
S Crucis	12 48.4	−57 53	6.5— 7.6	4 16.6	2 20; 12 5; 21 14; 30 23
W Virginis	13 20.9	− 2 52	8.7—10.4	17 06.5	14 11; 31 18
SS Hydrae	25.0	−23 08	7.4— 8.1	8 4.8	9 0; 17 5; 25 10
RV Urs. Maj.	13 29.4	+54 31	9.2— 9.9	0 11.2	3 9; 10 9; 24 10; 31 11
ST Virginis	14 22.5	− 0 27	10.3—11.4	0 09.9	6 5; 14 10; 22 15; 30 20
V Centauri	25.4	−56 27	6.4— 7.8	5 11.9	2 14; 8 2; 19 1; 30 1
RS Bootis	29.3	+32 11	8.9—10.0	0 09.1	6 8; 13 21; 21 10; 28 23
RU Bootis	14 41.5	+23 44	12.8—14.3	0 11.9	5 1; 12 10; 19 20; 27 6
R Triang. Austr.	15 10.8	−66 08	6.7— 7.4	3 09.3	1 20; 8 15; 22 5; 28 23
S Triang. Austr.	15 52.2	−63 29	6.4— 7.4	6 07.8	2 23; 9 7; 21 22; 28 6
S Normae	16 10.6	−57 39	6.6— 7.6	9 18.1	8 5; 17 23; 27 17
RW Draconis	33.7	+58 03	9.6—10.8	0 10.6	8 1; 16 22; 25 19
RV Scorpii	16 51.8	−33 27	6.7— 7.4	6 01.5	7 0; 13 2; 25 4; 31 6
X Sagittarii	17 41.3	−27 48	4.4— 5.0	7 00.3	4 19; 11 19; 18 20; 25 20
Y Ophiuchi	47.3	− 6 07	6.1— 6.5	17 02.9	4 2; 21 5
W Sagittarii	17 58.6	−29 35	4.3— 5.1	7 14.3	8 10; 16 1; 23 15; 31 5
Y Sagittarii	18 15.5	−18 54	5.4— 6.2	5 18.6	4 10; 10 5; 21 18; 27 13
U Sagittarii	26.0	−19 12	6.5— 7.3	6 17.9	7 11; 14 4; 20 22; 27 16
Y Scuti	32.6	− 8 27	8.7— 9.2	10 08.3	6 23; 17 7; 27 15
Y Lyrae	34.2	+43 52	11.3—12.3	0 12.1	6 15; 12 16; 24 17; 30 18
RZ Lyrae	39.9	+32 42	9.9—11.2	0 12.3	4 13; 10 16; 22 23; 29 2
RT Scuti	18 44.1	−10 30	9.1— 9.7	0 11.9	6 11; 12 10; 24 7; 30 6
κ Pavonis	18 46.6	−67 22	3.8— 5.2	9 02.2	3 4; 12 6; 21 8; 30 11
U Aquilae	19 24.0	− 7 15	6.2— 6.9	7 00.6	4 17; 11 17; 18 18; 25 19
XZ Cygni	30.4	+56 10	8.6— 9.3	0 11.2	5 6; 12 6; 19 6; 26 6
U Vulpec.	32.2	+20 07	6.5— 7.6	7 23.5	8 14; 16 13; 24 13
SU Cygni	40.8	+29 01	6.2— 7.0	3 20.3	8 3; 15 19; 23 12; 31 5
η Aquilae	47.4	+ 0 45	3.7— 4.5	7 04.2	6 17; 13 22; 21 2; 28 6
S Sagittae	51.5	+16 22	5.6— 6.4	8 09.2	7 19; 16 5; 24 14
X Vulpec.	19 53.3	+26 17	9.5—10.5	6 07.7	7 1; 13 8; 19 16; 25 23
X Cygni	20 39.5	+35 14	6.0— 7.0	16 09.3	10 23; 27 9
T Vulpec.	47.2	+27 52	5.5— 6.1	4 10.5	3 22; 12 19; 21 16; 30 13
WY Cygni	52.3	+30 03	9.6—10.4	0 13.5	3 1; 9 18; 23 5; 29 23
RV Capric.	55.9	−15 37	9.2—10.1	0 10.7	2 12; 9 5; 22 15; 29 8
TX Cygni	20 56.4	+42 12	8.5— 9.7	14 17.4	8 17; 23 10
VY Cygni	21 00.4	+39 34	8.8— 9.5	7 20.6	3 11; 11 7; 19 4; 27 0
SW Aquarii	10.2	− 0 20	9.9—10.8	0 11.0	1 12; 8 9; 22 4; 29 1
VZ Cygni	21 47.7	+42 40	8.2— 9.2	4 20.7	2 4; 11 21; 21 15; 31 8
Y Lacertae	22 05.2	+50 33	9.1— 9.6	4 07.8	5 11; 14 3; 22 18; 31 10
δ Cephei	25.5	+57 54	3.7— 4.6	5 08.8	4 16; 10 1; 20 18; 31 12
Z Lacertae	36.9	+56 18	8.2— 9.0	10 21.1	6 1; 16 22; 27 19
RR Lacertae	37.5	+55 55	8.5— 9.2	6 10.1	3 15; 10 1; 22 22; 29 8
V Lacertae	22 44.5	+55 48	8.2— 8.9	4 23.6	4 4; 9 4; 19 3; 29 2
SW Cassiop.	23 03.7	+58 11	9.2— 9.7	5 10.6	3 12; 8 22; 19 19; 30 16
RS Cassiop.	32.6	+61 52	9.0—11.0	6 07.1	2 2; 8 9; 20 23; 27 7
RY Cassiop.	47.2	+58 11	9.3—11.8	12 03.4	13 0; 25 4
V Cephei	23 51.7	+82 38	6.0—7.0	0 23.6	3 18; 8 18; 18 17; 28 16

Minima of Variable Stars of Short Period.

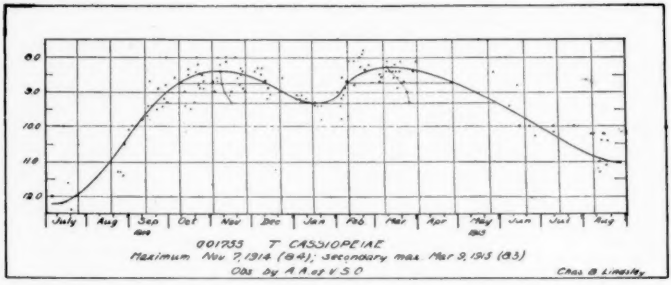
[Calculated by Agnes E. Wells at Goodsell Observatory.]

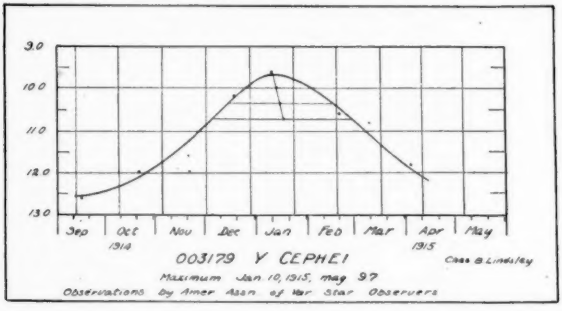
Given to the nearest hour in Greenwich mean time; to obtain Eastern Standard time subtract 5h; Central Standard 6h; etc.

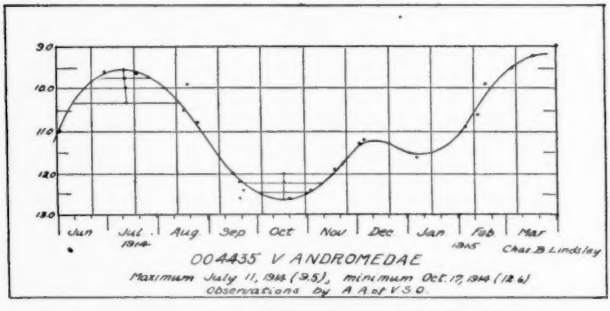
Star	R. A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich mean times of minima in 1916 January							
	h m	° ′		d h	d	h	d	h	d	h	d	h
SY Androm.	0 08.0	+43 09	9.5—13.0	34 21.8	5	8						
RT Sculptor.	31.5	—26 13	9.6—10.5	0 12.3	2	4;	9	20;	17	12;	25	4
UU Androm.	38.5	+30 24	10.7—11.9	1 11.7	4	17;	12	3;	14	14;	27	0
U Cephei	0 53.4	+81 20	7.0— 9.0	2 11.8	7	18;	15	5;	22	17;	30	4
Z Persei	2 33.7	+41 46	9.4—12	3 01.4	6	11;	12	14;	24	19;	30	22
TW Cassiop.	37.6	+65 19	8.2— 9.0	1 10.3			13	7;	20	11;	27	14
RY Persei	39.0	+47 43	8.0—10.3	6 20.7	3	2;	9	22;	23	16;	30	12
RZ Cassiop.	39.9	+69 13	6.9— 8.1	1 04.7	1	16;	8	21;	23	5;	30	9
TX Cassiop.	44.4	+62 22	9.4—10.1	2 22.2	7	3;	15	21;	24	16		
ST Persei	53.7	+38 47	8.5—10.5	2 15.6	8	3;	16	2;	24	1;	31	23
RX Cassiop.	58.8	+67 11	8.6— 9.1	32 07.6	8	23						
Algol	3 01.7	+40 34	2.3— 3.5	2 20.8	2	2;	7	20;	19	7;	30	18
RT Persei	16.7	+46 12	9.5—11.5	0 20.4	3	2;	9	21;	16	16;	30	6
λ Tauri	55.1	+12 12	3.3— 4.2	3 22.9	3	11;	11	8;	19	6;	27	4
RW Tauri	3 57.8	+27 51	7.1—<11	2 18.5	1	11:	9	18;	15	1;	26	9
RV Persei	4 04.2	+33 59	9.5—11.0	1 23.4	8	11;	16	8;	24	5		
RW Persei	13.3	+42 04	8.8—11.0	15 04.8			13	1;	26	5		
SZ Tauri	31.4	+18 20	7.2— 7.7	3 03.6	8	8;	17	19;	27	5		
RS Cephei	4 48.6	+80 06	9.5—12.0	12 10.1	3	12;	15	22;	28	8		
TT Aurigae	5 02.8	+39 27	7.8— 8.7	0 16.0	2	2;	8	18;	22	2;	28	18
RY Aurigae	11.5	+38 13	10.7—11.7	2 17.5	3	5;	8	16;	19	14;	30	12
RZ Aurigae	42.9	+31 40	10.6—13.3	3 00.3	1	8;	7	9;	19	10;	31	11
SV Tauri	45.8	+28 05	9.4—11.0	2 04.0	4	14;	13	6;	21	22;	30	14
Z Orionis	50.2	+13 40	9.7—10.7	5 04.9			14	6;	24	16		
SV Gemin.	54.6	+24 28	9.8—<11	4 00.2	3	7;	11	8;	19	8;	27	8
RW Gemin.	5 55.4	+23 08	9.5—11.0	2 20.8	4	7;	10	1;	15	18;	27	5
U Columbae	6 11.2	—33 03	9.2—10.0	2 19.2	1	15;	7	5;	18	10;	29	15
SX Gemin.	22.0	+20 37	10.8—11.5	1 08.8	2	16;	10	21;	19	2;	27	7
RW Monoc.	29.3	+ 8 54	9.0—10.8	1 21.7	4	14;	12	6;	19	20;	27	11
RX Gemin.	43.6	+33 21	8.8— 9.6	12 05.0			12	14;	24	19		
RU Monoc.	6 49.4	— 7 28	9.8—10.5	0 21.5	7	6;	14	10;	21	14;	28	19
R Can. Maj.	7 14.9	—16 12	5.8— 6.4	1 03.3	2	4;	11	5;	20	8;	29	10
RY Gemin.	21.7	+15 52	8.9—<10	9 07.2	7	14;	16	21;	26	4		
Y Camelop.	27.6	+76 17	9.5—12	3 07.3	5	1;	14	23;	24	21		
TX Gemin.	30.3	+17 8	10.0—11.9	2 19.2	1	20;	10	5;	18	15;	27	0
RR Puppis	43.5	—41 08	9.4—10.7	6 10.3	3	20;	10	7;	23	3;	29	14
V Puppis	7 55.4	—48 58	4.1— 4.8	1 10.9	5	5;	12	11;	19	18;	27	1
X Carinae	8 29.1	—58 53	7.9— 8.7	0 13.0	4	8;	12	11;	20	14;	28	17
S Cancri	8 38.2	+19 24	8.2—10	9 11.6	7	21;	17	8;	26	19		
RX Hydrae	9 00.8	— 7 52	9.1—10.5	2 6.8	1	12;	10	15;	19	18;	28	21
S Antliae	27.9	—28 11	6.7— 7.3	0 07.8	5	14;	12	1;	25	1;	31	12
S Velorum	29.4	—44 46	7.8— 9.3	5 22.4	2	18;	8	16;	20	13;	26	11
Y Leonis	9 31.1	+26 41	9.3—11.2	1 16.5	7	11;	15	21;	24	7		
RR Velorum	10 17.8	—41 36	10.0—10.9	1 20.5	8	23;	18	6;	27	12		
SS Carinae	10 54.2	—61 23	12.2—12.8	3 07.2	4	15;	11	6;	24	10;	31	0
ST Urs. Maj.	11 22.4	+45 44	6.7— 7.2	8 19.2	6	0;	14	19;	23	14		
RW Urs. Maj.	35.4	+52 34	10.3—11.4	7 07.9	7	18;	15	2;	22	10;	29	18
Z Draconis	11 39.8	+72 49	9.9—13.6	1 08.6	2	22;	9	17;	23	7;	30	2
RZ Centauri	12 55.6	—64 05	8.5— 8.9	1 21.0	6	6;	13	18;	21	6;	28	18
RS Can. Ven.	13 06.3	+36 28	7.5—12.5	4 19.2			10	4;	19	18;	29	8
SS Centauri	13 07.2	—63 37	8.8—10.4	2 11.5	6	12;	13	22;	21	9;	28	19
δ Librae	14 55.6	— 8 07	4.8— 6.2	2 07.9	6	10;	13	10;	20	9;	27	9

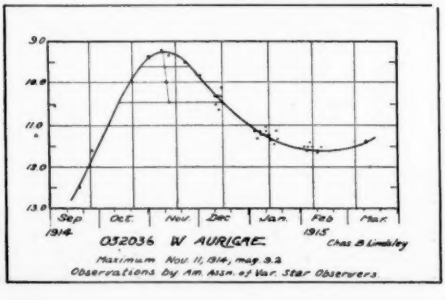
Minima of Variable Stars of Short Period—Continued.

Star	R. A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich mean times of minima in 1916 January
	h m	° ′		d h	d h d h d h d h d h
U Coronae	15 14.1	+32 01	7.6— 8.7	3 10.9	6 22; 13 20; 20 18; 27 15
TW Draconis	32.4	+64 14	7.3— 8.9	2 19.4	5 6; 13 16; 22 2; 30 12
SS Librae	15 43.4	—15 14	9.3—11.5	0 18.4	1 2; 8 18; 24 2; 21 17
SW Ophiuchi	16 11.1	— 6 44	9.2—10.0	2 10.7	1 1; 8 9; 23 1; 30 9
SX Ophiuchi	12.6	— 6 25	10.5—11.2	2 01.5	8 4; 16 10; 24 16
R Arae	31.1	—56 48	6.8— 7.9	4 10.2	3 10; 12 7; 21 3; 30 0
TT Herculis	16 49.9	+17 00	8.9— 9.3	20 18.1	9 1; 20 3; 29 19
TU Herculis	17 09.8	+30 50	9.5—12	2 06.4	6 14; 13 9; 20 4; 27 0
U Ophiuchi	11.5	+ 1 19	6.0— 6.7	0 20.1	8 12; 16 21; 25 6
u Herculis	13.6	+33 12	4.6— 5.4	2 01.2	3 3; 9 6; 21 14; 27 17
TX Herculis	15.4	+42 00	8.3— 9.0	1 00.7	7 14; 14 21; 22 2; 29 7
RV Ophiuchi	29.8	+ 7 19	9. —12	3 16.5	4 3; 11 12; 18 21; 26 6
SZ Herculis	36.0	+33 01	9.5—10.3	0 19.6	4 16; 12 21; 21 1; 29 5
TX Scorpii	48.6	—34 13	7.5— 8.2	0 22.6	6 4; 13 17; 21 6; 28 19
UX Herculis	49.7	+16 57	8.8—10.5	1 13.2	6 6; 14 0; 21 18; 29 12
Z Herculis	53.6	+15 09	7.1— 7.9	3 23.8	5 6; 13 5; 21 5; 29 5
WX Sagittae	53.6	—17 24	9.2—10.8	2 03.1	4 14; 13 2; 21 15; 30 3
WY Sagittae	17 54.9	—23 1	9.5—10.6	4 16.0	9 13; 18 21; 28 5
SX Draconis	18 03.0	+ 58 23	9.3—10.5	5 04.1	1 19; 12 3; 22 11
RS Sagittarii	11.0	—34 08	5.9— 6.3	2 10.0	1 6; 8 12; 23 0; 30 6
V Serpentis	11.1	—15 34	9.5—11.1	3 10.9	4 8; 11 6; 25 1; 31 23
RZ Scuti	21.1	— 9 15	7.4— 8.3	15 03.2	2 3; 17 6
RZ Draconis	21.8	+58 50	9.5—10.2	0 13.2	9 5; 17 11; 25 18
RX Herculis	26.0	+12 32	7.0— 7.6	0 21.3	8 14; 17 11; 26 9
SX Sagittarii	39.7	—30 36	8.7— 9.8	2 01.8	1 9; 9 16; 17 24; 26 7
RR Draconis	40.8	+62 34	9.3—13	2 19.9	2 15; 11 2; 19 13; 28 1
RS Scuti	43.7	—10 21	9.3—10.3	0 15.9	2 6; 8 22; 22 5; 28 20
β Lyrae	46.4	+33 15	3.4— 4.1	12 21.8	6 20; 19 18
U Scuti	18 48.9	—12 44	9.1— 9.6	0 22.9	2 19; 12 8; 21 21; 31 11
RX Draconis	19 01.1	+58 35	9.3—10.2	1 21.4	3 14; 11 4; 18 17; 26 7
RV Lyrae	12.5	+32 15	11. —12.8	3 14.4	6 14; 13 18; 20 23; 28 4
RS Vulpec.	13.4	+22 16	6.9— 8.0	4 11.4	3 0; 11 23; 20 22; 29 21
U Sagittae	14.4	+19 26	6.5— 9.0	3 09.1	2 24; 9 18; 23 6; 30 1
Z Vulpec.	17.5	+25 23	7.3— 8.5	2 10.9	2 11; 9 20; 24 13; 31 22
TT Lyrae	24.3	+41 30	9.3—11.6	5 05.8	2 17; 7 23; 18 11; 28 23
UZ Draconis	26.1	+68 44	9.0— 9.8	1 15.1	4 11; 11 0; 24 1; 30 13
SY Cygni	19 42.7	+32 28	10 —12	6 00.2	4 8; 10 8; 22 9; 28 9
WW Cygni	20 00.6	+41 18	9.3—13.4	3 07.6	6 16; 13 7; 19 22; 26 14
SW Cygni	03.8	+46 01	9. —11.7	4 13.8	7 1; 16 4; 25 8
VW Cygni	11.4	+34 12	9.8—11.8	8 10.3	4 7; 12 17; 21 3; 29 14
RW Capric.	12.2	—17 59	8.8—10.6	3 09.4	1 20; 8 14; 22 4; 28 23
UW Cygni	19.6	+42 55	10.5—13	3 10.8	3 21; 10 18; 24 14; 31 11
V Vulpec.	32.3	+26 15	8.2—9.8	37 19.0	7 15;
W Delphini	33.1	+17 56	9.4—12.1	4 19.4	2 11; 12 2; 21 17; 31 8
RR Delphini	38.9	+13 35	10.5—11.8	4 14.4	6 9; 15 14; 24 19
Y Cygni	48.1	+34 17	7.1— 7.9	1 12.0	1 6; 8 17; 23 17; 31 5
WZ Cygni	49.3	+38 27	9.9—10.8	0 14.0	5 21; 11 17; 23 9; 29 6
RR Vulpec.	20 50.5	+27 32	9.6—11.0	5 01.2	10 4; 20 6; 30 8
VV Cygni	21 02.3	+45 23	12.1—13.8	1 11.4	4 5; 11 14; 18 23; 26 8
AE Cygni	09.0	+30 20	10.8—11.4	0 23.3	7 5; 16 22; 26 14
RY Aquarii	14.8	—11 14	8.8—10.4	1 23.2	2 14; 10 11; 18 8; 26 5
UZ Cygni	55.2	+43 52	8.9—11.6	31 07.3	14 14
RT Lacertae	21 57.4	+43 24	9.1—10.5	5 01.7	2 3; 12 6; 22 9
RW Lacertae	22 40.6	+49 08	10.2—11.2	5 04.4	3 3; 8 8; 18 17; 29 2
X Lacertae	22 45.0	+55 54	8.2— 8.6	5 10.6	5 18; 11 5; 22 2; 27 13
TT Androm.	23 08.7	+45 36	11.3—12.6	2 18.3	2 11; 10 18; 19 1; 27 8
Y Piscium	29.3	+ 7 22	9.0—12.0	3 18.4	4 6; 11 18; 19 7; 26 20
TW Androm.	23 58.2	+32 17	8.6—11.5	4 02.9	8 15; 16 21; 25 3


6.0
9.0
10.0
11.0
12.0
July
Aug
Sep
1914
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
1915
Jun
Jul
Aug
001735 T CASSIOPEIAE
Maximum Nov 7, 1914 (8.4); secondary max. Mar 9, 1915 (8.3)
Obs by A.A.of V.S.O.
Chas. B. Lindsley


9.0
10.0
11.0
12.0
13.0
Sep
1914
Oct
Nov
Dec
Jan
Feb
Mar
Apr
1915
May
003179 Y CEPHEI
Chas B Lindsley
Maximum Jan 10, 1915, mag 9.7
Observations by Amer Assn of Var Star Observers


9.0
10.0
11.0
12.0
13.0
Jun
Jul
1914
Aug
Sep
Oct
Nov
Dec
Jan
1915
Feb
Mar
Chas B Lindsley
004435 V ANDROMEDAE
Maximum July 11, 1914 (9.5), minimum Oct. 17, 1914 (12.6)
Observations by A.A.of V.S.O.


9.0
10.0
11.0
12.0
13.0
Sep
1914
Oct.
Nov.
Dec
Jan.
Feb
1915
Mar.
Chas B Lindsley
032036 W AURIGAE
Maximum Nov. 11, 1914, mag. 9.2
Observations by Am. Assn. of Var. Star Observers

COMET AND ASTEROID NOTES.

Comet 1915 *d* (Mellish).—The accompanying diagram, prepared by means of the elements in POPULAR ASTRONOMY for November, p. 615, will show at a glance why Mellish's comet *d* 1915 has not been observable since the first few days after discovery. It was moving rapidly eastward and southward on the far side of

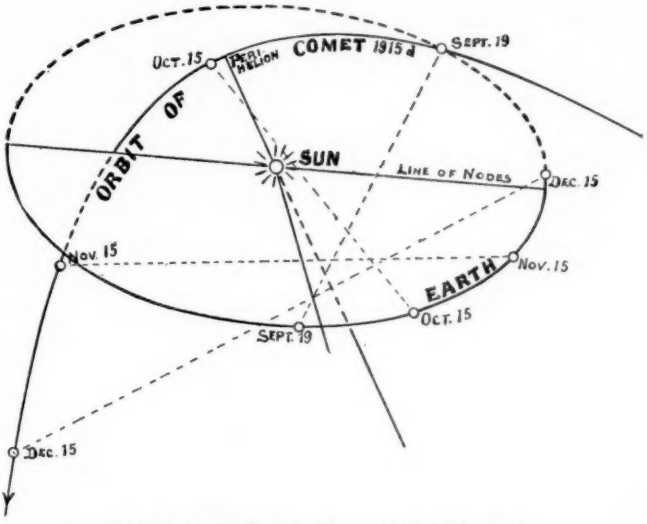


DIAGRAM OF THE ORBIT OF COMET 1915 *d* (MELLISH).

the sun. When it came out from behind the sun in November it was too far south to be easily seen in our northern latitudes and now it is too far from the earth to be observed anywhere, probably.

The following ephemeris is a continuation of the one on page 615, computed by S. Einarsson and Dinsmore Alter of the Students' Observatory, University of California.

EPHEMERIS OF COMET 1915 *d* (MELLISH).

		α	δ	log Δ	Br.
		h m	° ′		
Dec.	4.5	18 03.2	−44 00	0.3070	0.15
	6.5	12.1	44 39		
	8.5	21.0	45 15	0.3211	
	10.5	29.8	45 48		
	12.5	38.5	46 17	0.3348	0.11
	14.5	47.2	46 44		
	16.5	18 55.7	47 08	0.3480	
	18.5	19 04.2	47 30		
	20.5	12.5	47 49	0.3608	0.08
	22.5	20.8	48 06		
	24.5	28.9	48 20	0.3731	
	26.5	37.0	48 33		
	28.5	44.9	48 44	0.3849	0.06
Dec.	30.5	19 52.7	−48 53		

Comet 1915 *a* (Mellish).—The following ephemeris of comet 1915 *a* (Mellish) is taken from the *Astronomische Nachrichten* No. 4817. The computation was by J. Braae and J. Fischer-Peterson of Copenhagen.

EPHEMERIS OF COMET 1915 *a* (MELLISH).

For Berlin Midnight.

		α	δ	log r	log Δ	Mag.
		h m s	° ′ ″			
Dec.	5	4 1 26	+ 2 17.4	0.3771	0.1593	9.0
	7	3 57 50	2 58.2			
	9	54 25	3 38.3	0.3857	0.1771	9.2
	11	51 10	4 17.4			
	13	48 07	4 55.8	0.3942	0.1958	9.3
	15	45 15	5 33.1			
	17	42 34	6 09.6	0.4024	0.2151	9.4
	19	40 04	6 45.2			
	21	37 45	7 19.8	0.4105	0.2349	9.6
	23	35 36	7 53.5			
	25	33 38	8 26.3	0.4184	0.2549	9.7
	27	31 50	8 58.2			
	29	30 11	9 29.2	0.4262	0.2749	9.8
	31	28 43	9 59.4			
Jan.	2	3 27 24	+10 28.8	0.4337	0.2949	10.0

The correction to the ephemeris on September 10 was -1^s, 0.′0.

NOTES FOR OBSERVERS.

Monthly Report of the American Association of Variable Star Observers, Oct.-Nov., 1915.

The following observers have recently joined the Association:

Mr. Howard D. Miner, "Mr" of New York City.
Mr. Thurston Hatcher, "Hr" of Atlanta, Ga.
Mr. Lucius Henderson, "He" of Atlanta, Ga.

The steady increase in our membership is most gratifying and encouraging. Twenty-five observers contribute to this report, the largest number since the publication of the reports.

Mr. Mach's list of eighty observations for the last report was lost in the mail; to complete our records it is included in this month's observations. Mr. Mach observes with a glass of only two-inch aperture, and deserves credit for the great amount of valuable work he accomplishes with it.

We congratulate Dr. Gray on the recovery of his health, and welcome his contributions to this report.

Mr. Lindsley is now located in Cincinnati, O., and resumes his contributions of estimates this month. The Association is indebted to him for the skillfully executed curves that he continues to publish in POPULAR ASTRONOMY.

Mr. Richter has pointed out a defect in the blue print of the variable 194048 RT Cygni. The dot indicating a star of about the 7.5 magnitude immediately south of the 7.5 magnitude comparison star should be erased, as there is no such star in this location. A more accurate chart of the variable 013238 RU Andromedae will soon be distributed. A defective chart of this variable has led to mistakes in identification.

Variable Star Observations Oct.-Nov., 1915.

001046
X Androm.

Mo.	Day	Est	Obs.
10	6	13.5	B

001032
S Sculptoris

Mo.	Day	Est	Obs.
10	8	10.9	Ho
	10	11.0	Ba
	28	9.8	Ba

001726
T Androm.

Mo.	Day	Est	Obs.
10	3	9.0	Sp
	4	9.1	O
	9	8.4	Ba
	9	9.0	O
	10	8.8	R
	10	8.4	Sp
	16	8.4	O
	24	8.4	O
	28	8.3	V
	28	8.4	Ba
11	2	8.8	O
	2	8.6	S
	7	8.8	O

001755
T Cassiop.

Mo.	Day	Est	Obs.
10	3	11.5	Ba
	4	11.1	B
	12	10.0	Nt
	15	10.4	M
	26	9.9	M
	27	9.9	Nt

001838
R Androm.

Mo.	Day	Est	Obs.
10	8	11.4	M
	10	11.6	Ba
	10	11.3	M
	12	11.3	Hu

001909
S Ceti

Mo.	Day	Est	Obs.
10	3	9.0	Sp
	3	9.0	Ba
	8	8.9	Ho
	10	8.8	R
	10	9.0	Pi
	13	8.9	Sp
	17	8.8	Sp
	30	10.6	Hu
	30	8.2	Pi
11	1	8.5	S

003179
Y Cephei

Mo.	Day	Est	Obs.
10	10	12.8	Ba
	28	12.7	Ba

004047
U Cassiop.

Mo.	Day	Est	Obs.
10	3	8.9	MBa
	3	9.0	Ba
	4	8.9	B
	10	8.5	Ba
	10	9.0	L
	15	8.8	M
	28	8.2	Ba
11	2	8.4	S

004132
RW Androm.

Mo.	Day	Est	Obs.
10	3	12.0	Ba

004435
V Androm.

Mo.	Day	Est	Obs.
10	3	12.5	Ba
	9	12.3	Ba
	12	11.3	Hu
	28	11.3	Ba
	30	11.0	O
11	2	11.0	O
	7	10.7	O

004533
RR Androm.

Mo.	Day	Est	Obs.
10	3	9.7	Ba
	4	9.5	O
	9	9.5	O
	10	9.1	Ba
	11	9.6	O
	12	9.3	Hu
	16	9.6	O
	25	9.6	O
	28	9.5	Ba
	30	9.6	O
11	2	9.8	O
	7	9.6	O

004746
RV Cassiop.

Mo.	Day	Est	Obs.
10	3	7.6	Ba
	8	9.0	L
	10	7.7	Ba
	28	9.2	Ba

004958
W Cassiop.

Mo.	Day	Est	Obs.
10	3	10.6	Ba
	10	10.4	Ba
	26	8.8	M
	28	10.8	Ba

011272
S Cassiop.

Mo.	Day	Est	Obs.
10	3	13.3	Ba
	4	12.3	B
	30	13.0	Y

012350
RZ Persei

Mo.	Day	Est	Obs.
10	10	12.5	Ba

012502
R Piscium

Mo.	Day	Est	Obs.
10	10	11.0	Ba
	28	8.7	Ba
	30	9.1	Pi
11	2	9.0	S

013238
RU Androm.

Mo.	Day	Est	Obs.
10	28	10.4	Pi
11	3	10.2	O

013238
Y Androm.

Mo.	Day	Est	Obs.
10	9	10.2	O
	10	9.6	Ba
	11	10.0	O
	28	10.0	Pi
11	3	10.0	O

014958
X Cassiop.

Mo.	Day	Est	Obs.
10	4	11.9	B
	10	12.3	Ba
	11	11.2	M

015254
U Persei

Mo.	Day	Est	Obs.
10	3	8.8	Sp
	8	8.7	Pi
	10	8.6	Ba
	11	8.8	M
	17	8.6	Sp
	28	8.8	V

021024
R Arietis

Mo.	Day	Est	Obs.
9	6	8.1	Ma
	11	8.0	Ma
10	6	8.7	Pi
	10	8.2	Ba
	10	8.3	Ma
	10	9.0	Pi
	11	8.8	O
	12	8.6	Hu
	27	9.6	Pi
	28	9.9	Ba
	30	10.0	O
	30	10.0	Pi

021403
o Ceti

Mo.	Day	Est	Obs.
11	1	8.3	E
	8	7.8	Ho
	8	8.2	L
	11	7.7	Ba
	11	8.1	Pi
	16	8.0	L
	30	6.5	Hu
	30	7.8	Pi
	3	6.8	G

021558
S Persei

Mo.	Day	Est	Obs.
10	3	8.9	Sp
	4	8.7	B
	5	9.0	R
	6	9.7	Pi
	8	9.5	Pi
	10	8.8	Sp
	11	8.5	Ba
	11	9.3	Pi
	11	8.9	M
	17	8.9	Sp
	28	8.5	Ba

022813
U Ceti

Mo.	Day	Est	Obs.
10	28	7.4	Ba
	30	7.5	Pi

023133
R Triang.

Mo.	Day	Est	Obs.
10	1	10.0	E
	3	10.4	Ba
	4	10.0	B
	12	10.2	Hu
	17	11.0	Sp
11	2	10.6	O

024356
W Persei

Mo.	Day	Est	Obs.
9	11	9.7	Ma
10	3	9.1	Ba
	5	9.8	R
	6	9.4	Pi
	11	9.7	Pi
	11	10.2	O
	11	10.4	M
	12	9.4	Hu
	27	9.8	Pi
	28	9.4	Ba
	3	9.0	G

032043
Y Persei

Mo.	Day	Est	Obs.
9	6	8.8	Ma
	11	8.7	Ma
	3	8.5	Ba
	4	8.6	B
	8	8.5	Pi
	10	9.0	Ma
	11	9.6	M
	12	8.9	Hu
	12	8.6	B
	29	9.5	Ma
	29	9.7	Ly
11	3	9.5	G

032335
R Persei

Mo.	Day	Est	Obs.
10	3	8.5	Ba
	8	8.5	Pi
9	11	8.4	M
10	12	8.4	Hu
	28	8.5	Pi
	1	9.2	S

033362
U Camelop.

Mo.	Day	Est	Obs.
9	6	8.0	Ma
	11	8.3	Ma
10	10	8.6	M
	10	8.6	Ma
	11	7.7	Ba
	30	8.8	Pi

042209
R Tauri

Mo.	Day	Est	Obs.
10	3	11.9	Sp
	8	12.0	M
	30	11.3	Hu

042215
W Tauri

Mo.	Day	Est	Obs.
10	8	12.3	M
	11	12.4	Ba
	30	12.0	Hu

042309
S Tauri

Mo.	Day	Est	Obs.
10	8	10.5	M
	30	10.0	Hu

043065
T Camelop.

Mo.	Day	Est	Obs.
10	8	11.4	M
	11	13.0	Ba

043208
RX Tauri

Mo.	Day	Est	Obs.
10	16	12.0	Y
	30	9.6	Hu
	30	10.8	Pi
	30	10.6	Y

043274
X Camelop.

Mo.	Day	Est	Obs.
10	3	9.5	Sp
	3	9.1	Ba
	6	9.5	Pi
	11	9.0	O
	11	8.7	Pi
	11	8.7	Ba
	13	8.7	Sp
	16	8.7	L
	17	8.6	Sp
	27	8.0	Pi
	28	8.2	Pi
	30	8.2	O
	30	8.3	Pi
	2	8.2	O
	7	8.0	O

045514
R Leporis

Mo.	Day	Est	Obs.
26	7.1	Ho
6	6.8	Ho
8	7.0	L
13	6.6	Ho
16	6.6	L

VARIABLE STAR OBSERVATIONS Oct.-Nov., 1915—Continued.

050022
T Leporis

Mo.	Day	Est.	Obs.
10	6	10.4	Ho

059953
R Aurigae

Mo.	Day	Est.	Obs.
10	11	12.4	Ba
	13	11.0	M
	13	12.5	Sp

052036
W Aurigae

Mo.	Day	Est.	Obs.
10	11	12.0	Ba

052034
S Aurigae

Mo.	Day	Est.	Obs.
10	8	10.2	Pi
	11	10.1	Ba
	30	10.0	Pi

052405
S Orionis

Mo.	Day	Est.	Obs.
10	6	9.4	Ho
	22	8.4	Ho
	26	8.4	M
	31	8.2	M

053005
T Orionis

Mo.	Day	Est.	Obs.
10	3	9.4	Sp
	6	9.6	Ho
	14	9.8	Sp
	15	10.0	M
	22	9.8	Ho
	26	9.6	M
	30	9.6	Pi
	31	9.5	M

054974
V Camelop.

Mo.	Day	Est.	Obs.
10	6	13.2	Y

054920
U Orionis

Mo.	Day	Est.	Obs.
10	16	9.4	L
	31	9.7	M

055353
Z Aurigae

Mo.	Day	Est.	Obs.
10	11	11.0	Pi
	13	11.2	M

060224
S Leporis

Mo.	Day	Est.	Obs.
10	6	6.7	Ho
	22	6.3	Ho

060450
X Aurigae

Mo.	Day	Est.	Obs.
10	11	10.0	Pi
	11	12.8	Ba
	16	11.9	L

061702
V Monoc.

Mo.	Day	Est.	Obs.
10	11	11.0	Ho

063159
U Lyncis

Mo.	Day	Est.	Obs.
10	11	11.8	Ba

063558
S Lyncis

Mo.	Day	Est.	Obs.
10	11	13.0	Ba
	14	12.6	Sp
	18	12.6	Sp

064932
Nova Gemin.

Mo.	Day	Est.	Obs.
10	16	12.0	L

065208
X Monoc.

Mo.	Day	Est.	Obs.
10	11	7.6	Ho

065355
R Lyncis

Mo.	Day	Est.	Obs.
10	11	10.7	Ba

070122 a
R Gemin.

Mo.	Day	Est.	Obs.
10	18	6.5	Sp

070310
R Can. Min.

Mo.	Day	Est.	Obs.
10	16	9.4	L

072708
S Can. Min.

Mo.	Day	Est.	Obs.
10	8	10.0	L
	15	9.4	M
	27	9.0	M

073508
U Can. Min.

Mo.	Day	Est.	Obs.
10	8	9.7	L

075813
U Puppis

Mo.	Day	Est.	Obs.
10	11	12.0	Ho

082405
RT Hydrae

Mo.	Day	Est.	Obs.
10	11	7.5	Ho
	16	7.6	L

085120
T Cancri

Mo.	Day	Est.	Obs.
10	16	9.0	L

090151
V Urs. Maj.

Mo.	Day	Est.	Obs.
10	16	9.8	L
	30	10.2	Y

094211
R Leonis

Mo.	Day	Est.	Obs.
10	8	5.9	L
	27	5.9	M

094622
Y Hydrae

Mo.	Day	Est.	Obs.
10	22	6.5	Ho

095421
V Leonis

Mo.	Day	Est.	Obs.
10	27	10.8	M

103769
R Urs. Maj.

Mo.	Day	Est.	Obs.
10	3	11.9	Ba
	3	11.8	M
	10	11.8	Ba
	27	11.2	M
	28	10.9	Ba
	31	11.1	M

104620
V Hydrae

Mo.	Day	Est.	Obs.
10	22	7.0	Ho

123160
T Urs. Maj.

Mo.	Day	Est.	Obs.
8	30	7.9	Ma
9	6	8.2	Ma
	12	8.1	Ma
	26	7.8	R
	3	7.8	Ba
	3	8.1	M
	5	8.2	R
	10	8.2	R
	10	7.8	Ba
	15	7.6	Ly
	20	7.9	Ly
	23	8.0	Ly
	27	8.3	Ba
	27	8.1	Ly
	31	8.4	M

123961
S Urs. Maj.

Mo.	Day	Est.	Obs.
10	3	11.5	M
	10	11.6	L
11	2	10.3	O
	7	10.3	O
	15	11.0	Ly
	23	11.1	Ly
	27	11.2	Ly
	31	10.7	M

133273
T Urs. Min.

Mo.	Day	Est.	Obs.
10	3	9.5	Ba
	9	9.5	Ba
	27	10.1	Ba

134440
R Can. Venat.

Mo.	Day	Est.	Obs.
10	10	10.4	L

141567
U Urs. Min.

Mo.	Day	Est.	Obs.
10	3	9.9	Ba
	9	9.7	Ba
	12	9.5	Ba
	27	9.0	Ba
11	3	9.1	S

141954
S Bootis

Mo.	Day	Est.	Obs.
9	26	8.8	R
10	3	8.7	Ba
	4	8.8	Bu
	5	8.5	R
	9	8.5	Ba
	10	8.3	R
	10	8.4	M
	10	8.7	L
	12	8.6	Ba
	27	9.0	Ba

142539
V Bootis

Mo.	Day	Est.	Obs.
9	26	7.8	R
10	3	7.7	Ba
	4	7.7	Bu
	5	7.2	R
	9	7.4	Ba
	10	7.8	R
	10	7.7	M
	10	8.0	L
	12	7.4	Ba
	28	7.4	Ba

142584
R Camelop.

Mo.	Day	Est.	Obs.
10	3	8.5	Ba
	4	8.7	O
	4	8.8	Bu
	7	9.0	R
	9	9.0	O
	16	9.2	O
	24	9.5	O
	27	9.5	Ba
	29	10.0	Ly
	30	10.0	O

143227
R Bootis

Mo.	Day	Est.	Obs.
10	3	8.7	Ba
	8	8.6	R
	9	8.3	Ba
	10	8.5	L
	10	8.6	R
	10	8.3	M
	12	8.2	Ba

151715
S Serpentis

Mo.	Day	Est.	Obs.
10	10	10.9	L

151731
S Cor. Bor.

Mo.	Day	Est.	Obs.
9	30	12.6	B
10	31	11.6	M

153378
S Urs. Min.

Mo.	Day	Est.	Obs.
9	26	9.9	R
10	3	10.1	Ba
	5	11.0	R
	9	10.4	Ba
	10	10.6	R
	16	10.5	L
	27	10.7	Ba

S Urs. Min.

Mo.	Day	Est.	Obs.
10	28	11.2	Nt
	29	10.0	Ly
	31	11.0	G

154428
R Cor. Bor.

Mo.	Day	Est.	Obs.
8	30.5	7.9	Ma
	31.5	7.9	Ma
9	3.6	7.8	Ma
	6.5	7.6	Ma
	8.5	7.1	Ma
	10.5	6.8	Ma
	11.6	6.9	Ma
	12.5	6.8	Ma
	13.5	6.8	Ma
	14.5	6.8	Ma
	15.5	6.7	Ma
	16.5	6.7	Ma
	22.3	6.3	L
	24.5	6.4	Ma
	26.6	6.0	R
	27.6	6.8	Mu
	29.5	6.4	Ma
	29.6	6.9	Mu
	30	6.1	B
10	1.5	6.4	Cr
	2.5	6.2	Ma
	2.6	6.9	Mu
	3.5	6.1	Ma
	3.5	6.4	Ba
	3.6	6.9	Mu
	4.4	6.5	O
	4.5	6.6	Bu
	4.5	6.5	Cr
	5.6	5.5	R
	6.5	6.7	V
	6.5	6.4	Cr
	7.3	6.0	L
	7.6	5.5	R
	8.5	6.2	Ba
	8.6	6.7	Mu
	8.6	5.4	R
	9.4	6.1	Ba
	9.6	6.0	M
	10.3	6.1	L
	10.4	6.2	O
	10.4	6.0	Ba
	10.5	6.1	Ma
	10.6	6.7	Mu
	10.6	6.3	Nt
	10.6	5.4	R
	11.5	6.0	Ba
	11.6	6.8	Mu
	12	6.0	B
	12.4	6.0	Ba
	12.5	6.0	O
	12.5	6.2	Nt
	13.5	6.4	Cr
	16.5	6.2	Cr
	16.5	6.0	Ma

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R Cor. Bor.

Mo.	Day	Est.	Obs.
10	17.5	6.0	Cr
	24.5	6.0	Ma
	24.5	6.3	Nt
	27.5	6.0	M
	27.5	5.6	Ba
	28.5	5.7	Ba
	28.5	6.2	Nt
	30.5	6.3	Nt
	31.5	6.0	M

154536
X Cor. Bor.

10	3	10.0	Ba
	9	9.9	Ba
	12	9.5	Ba
	28	9.6	Ba

154539
V Cor. Bor.

10	3	9.5	Ba
	9	9.3	Ba
	12	8.5	Ba
	28	8.1	Ba

155847
X Herculis

10	24	6.4	Nt
	30	6.7	Nt

160118
R Herculis

10	6	9.7	Hr

160625
RU Herculis

10	11	13.2	B

161138
W Herculis

10	3	11.7	Ba
	9	11.5	Ba
	12	11.2	Ba
	27	11.2	Ba

162119
U Herculis

9	26	11.1	R
10	3	11.2	Ba
	4	10.9	Bu
	5	11.6	R
	9	11.4	Ba
	10	10.8	M
	11	11.5	B
	30	11.1	Nt

162807
SS Herculis

10	3	12.3	Ba
	6	12.3	Ba
	9	12.3	Ba
	10	12.2	Ba
	11	12.4	B
	12	12.2	Ba

163137
W Herculis

Mo.	Day	Est.	Obs.
10	3	12.2	Ba
	11	11.0	Hu
	11	12.5	B

163172
R Urs. Min.

9	6	9.6	Ma
	11	9.5	Ma
	14	9.2	Ma
	26	9.4	R
	28	9.8	E
10	3	9.1	Ba
	4	9.4	Ba
	5	9.5	R
	7	9.4	Ma
	8	9.4	E
	9	9.1	Ba
	10	9.4	R
	11	8.5	Hr
	12	9.3	Ba
	27	8.9	Ba
	29	9.7	Ly

163266
R Draconis

8	30	7.8	Ma
9	6	8.0	Ma
	11	8.3	Ma
	26	9.3	R
	28	9.3	E
	29	9.0	Ma
10	1	9.2	Cr
	3	9.4	Ba
	4	9.2	O
	4	9.5	Bu
	4	9.1	Cr
	5	10.2	R
	6	9.3	Cr
	7	9.4	Ma
	8	9.6	E
	9	9.6	Ba
	9	9.4	O
	10	10.3	R
	11	9.5	M
	12	9.7	Ba
	13	9.6	Cr
	16	10.4	Cr
	17	10.3	Cr
	22	11.0	Cr
	24	10.6	Cr
	27	10.5	Ba
	29	10.7	Ly

164055
S Draconis

9	26	8.8	R
10	4	9.8	Bu
	5	8.9	R
	10	9.0	R
	11	8.7	M

164715
S Herculis

10	3	11.8	Ba
	11	12.0	B

165631
RV Herculis

10	3	13.5	M

170627
RT Herculis

10	8	12.5	Ba
	11	12.5	B
	12	12.6	Ba

171401
Z Ophiuchi

10	8	11.7	Ba

171723
RS Herculis

10	3	8.2	Ba
	4	8.4	Bu
	7	7.9	R
	9	8.0	Ba
	10	8.5	L
	11	8.3	Nt
	11	8.2	B
	12	7.9	Ba
	12	8.3	O
	12	8.4	V
	27	8.5	V
	28	8.3	Ba
	28	8.3	Nt

172708
RU Ophiuchi

10	10	9.4	M
	27	9.0	V

175458
T Draconis

9	26	10.8	R
10	4	10.0	Ba
	5	9.9	R
	6	9.7	Y
	8	9.8	Ba
	8	10.4	E
	10	10.4	R
	11	10.0	M
	12	10.6	V
	27	9.5	Y
	27	10.3	V
	28	9.5	Ba

175519
RY Herculis

10	27	13.4	Y

180531
T Herculis

8	31	8.4	Ma
	11	8.7	Ma
	26	9.6	R

T Herculis

Mo.	Day	Est.	Obs.
10	3	9.6	Ba
	3	9.7	Ma
	5	10.4	R
	6	9.6	O
	9	10.2	Ba
	10	10.6	Hu
	10	10.5	R
	10	11.0	M
	11	9.8	Bu

180565
W Draconis

10	11	11.2	M

180666
X Draconis

10	11	10.5	M

181136
W Lyrae

8	31	8.6	Ma
9	6	8.9	Ma
	13	8.4	Ma
	26	10.9	R
10	3	11.0	Ba
	9	11.6	M
	9	11.7	Ba
	10	11.6	Hu
	11	11.6	B
	11	11.0	Bu
	27	12.3	Ba

181103
RY Ophiuchi

10	27	10.2	V

182224
SV Herculis

10	12	10.9	O
	12	10.9	B

183225
RZ Herculis

10	12	10.0	O
	31	10.1	O

183308
X Ophiuchi

8	30	7.3	Ma
9	6	7.2	Ma
	11	7.0	Ma
	13	6.8	Ma
	26	7.0	R
10	3	6.7	Ma
	5	6.9	R
	6	6.5	Ba
	10	7.0	R
	10	6.3	M
	10	6.7	L
	11	8.7	Hr
	11	6.5	Bu
	12	6.9	V
	12	6.5	Ba
	27	6.6	Ba
	27	6.9	V

184205
R Scuti

Mo.	Day	Est.	Obs.
9	26.6	5.2	R
	27.6	6.5	Mu
	29.4	6.3	L
	29.5	6.3	Ma
	29.6	7.0	Mu
10	2.6	7.2	Mu
	3.5	6.8	Ba
	3.5	7.1	Mu
	4.4	7.3	O
	5.6	6.5	R
	6.5	7.1	Ba
	6.5	7.4	O
	6.5	6.5	Pi
	6.6	6.9	Nt
	7.6	6.7	R
	8.5	7.1	Ba
	8.6	7.3	Mu
	8.6	7.0	R
	9.5	7.1	Ba
	9.5	7.4	O
	10.3	6.8	L
	10.4	7.2	Ba
	10.5	7.1	Nt
	10.5	7.0	Hu
	10.6	7.4	Mu
	10.6	7.5	R
	11.5	7.5	O
	11.5	7.2	Ba
	11.5	7.0	Pi
	11.5	7.7	Bu
	11.6	7.5	Mu
	12.4	7.2	Ba
	17.5	6.9	Pi
	24.5	5.8	Nt
	24.5	5.6	Ba
	26.5	5.8	Ma
	27.5	5.8	Ba
	27.6	5.7	Nt
	28.4	5.5	Pi
	28.5	5.7	Ba
	29.5	5.6	Ma
	30.4	5.3	Pi
	30.6	5.6	Nt
	31.6	5.8	G

184243
RW Lyrae

10	12	12.7	B
	12	13.0	Ba
	27	12.2	Ba

185243
R Lyrae

9	26.6	4.2	R
	27.7	4.2	R
	29.7	4.3	R
10	5.6	3.9	R

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190108
R Aquilae

Mo.	Day	Est.	Obs.
10	8	5.9	R
	9	6.5	Ba
	10	6.5	L
	11	6.0	Bu
	28	6.9	Ba
	29	7.7	M

190926
X Lyrae

Mo.	Day	Est.	Obs.
8	31	9.1	Ma
9	11	9.2	Ma
	26	9.8	R
10	3	9.0	Ba
	3	9.2	Ma
	5	9.7	R
	9	9.2	M
	10	9.6	R
	11	9.8	Bu
	12	8.6	Ba
	23	9.2	Ly
	27	9.3	Ly
	28	8.8	Ba

191019
R Sagittarii

Mo.	Day	Est.	Obs.
10	8	7.0	R

191033
RY Sagittarii

Mo.	Day	Est.	Obs.
10	5	6.7	R
	8	6.5	R
	19	6.1	R

191637
U Lyrae

Mo.	Day	Est.	Obs.
9	28	12.0	E
10	6	12.5	Ba
	28	12.6	Ba

192928
TY Cygni

Mo.	Day	Est.	Obs.
10	3	14.0	M

193311
RT Aquilae

Mo.	Day	Est.	Obs.
	10	12.3	L

193449
R Cygni

Mo.	Day	Est.	Obs.
9	26	11.2	R
10	3	9.8	M
	4	9.5	B
	5	11.6	R
	6	9.6	Hu
	7	11.3	R
	8	10.8	E
	8	11.0	Ba
	10	11.2	R
	11	11.2	O
	12	11.0	Ba
	27	11.2	Ba
	30	11.0	G
	31	11.4	M

193509
RV Aquilae

Mo.	Day	Est.	Obs.
9	28	10.0	E
10	6	11.0	Hr
	8	10.1	Ba
	11	9.8	Bu
	28	10.2	Ba

193732
TT Cygni

Mo.	Day	Est.	Obs.
8	31	8.4	Ma
9	8	8.0	Ma
	26	8.4	R
10	5	8.4	R
	6	7.4	Hu
11	8	7.2	Ba
	10	8.3	R
	11	8.1	Pi
	12	8.0	Ma
	16	8.7	Bu
	23	8.1	Ly
	26	7.3	Ma
	27	8.0	Ly
	28	7.1	Ba
	31	8.7	M

194048
RT Cygni

Mo.	Day	Est.	Obs.
9	11	9.1	Ma
10	6	7.0	Hu
	7	7.2	Ma
	7	7.2	R
	8	7.2	Ba
	9	7.6	M
	10	7.0	R
	11	7.0	O
	12	7.3	Ba
	16	7.1	O
	16	8.2	Bu
	25	7.5	O
	27	7.4	Ba
	27	8.1	Ly
	29	7.4	Ma
	30	7.9	G
	30	7.5	O
	31	8.0	M
11	3	7.5	O
	7	7.8	O

194348
TU Cygni

Mo.	Day	Est.	Obs.
10	3	12.0	M
	8	12.4	E
	8	12.2	Ba
	12	12.0	Ba
	27	12.2	Ly
	27	10.3	Ba
	31	9.0	M

194604
X Aquilae

Mo.	Day	Est.	Obs.
10	27	11.7	M

194632
***χ* Cygni**

Mo.	Day	Est.	Obs.
	6	10.5	Hu
	8	11.1	E
	8	11.0	Ba
	9	10.7	M
	12	10.6	Ba
	12	10.6	Y
	16	9.0	Bu
	23	10.3	M
	25	10.6	O
	27	10.3	Ba
	30	10.4	O
	31	10.0	M
11	3	10.4	O
	7	10.3	O

195116
S Sagittae

Mo.	Day	Est.	Obs.
9	16.5	6.0	Ma
	24.5	5.8	Ma
	26.7	5.5	R
	27.6	5.5	Mu
	29.5	5.4	Ma
	29.6	5.6	Mu
10	1.7	5.9	Mu
	2.6	5.9	Mu
	3.6	5.8	Mu
	4.4	5.7	O
	5.6	5.5	R
	6.5	5.4	R
	6.7	5.6	Mu
	7.6	5.5	R
	8.6	6.2	R
	8.6	5.5	Mu
	9.8	5.8	O
	10.4	6.1	O
	10.6	5.6	Mu
	10.6	5.9	R
	11.5	5.8	O
	11.6	5.8	Mu
10	12.5	5.8	O
	12.7	5.7	Mu
	16.5	5.4	O
	16.5	6.3	Bu
	24.4	5.4	O
	24.5	5.6	Ma
	25.4	5.9	O
	26.5	5.7	Ma
	27.4	6.2	O
	27.6	5.7	Ma
	28.5	5.9	O
	30.4	5.4	O
	31.4	5.4	O
11	2.4	5.7	O
	3.4	5.6	O
	7.4	5.4	O

195849
Z Cygni

Mo.	Day	Est.	Obs.
10	3	12.4	M
	8	12.5	Ba
	20	12.3	Ly

Z Cygni

Mo.	Day	Est.	Obs.
10	23	12.2	Ly
	27	12.3	Ly
	28	12.5	Ba

200212
SY Aquilae

Mo.	Day	Est.	Obs.
9	30	13.0	B

200647
SV Cygni

Mo.	Day	Est.	Obs.
8	30	8.8	Ma
9	8	8.7	Ma
	12	8.6	Ma
	26	9.0	R
10	5	8.9	R
	6	8.2	Hu
	7	8.8	Ma
	8	8.2	Ba
	9	8.9	M
	10	8.8	R
	11	9.2	Pi
	16	8.8	Bu
	23	9.2	Ly
	27	9.3	Ly
	28	8.1	Ba
	29	9.2	Ma

200715a
S Aquilae

Mo.	Day	Est.	Obs.
10	7	11.0	R
	8	10.4	Ba
	28	9.6	Ba
	29	9.6	M

200715 b
RW Aquilae

Mo.	Day	Est.	Obs.
9	26	8.9	R
10	5	9.3	R
	7	8.6	R
	8	9.1	Ba
	8	8.5	R
	10	8.8	R
	28	9.1	Ba
	29	8.8	M

200812
RU Aquilae

Mo.	Day	Est.	Obs.
9	30	9.9	B
10	8	10.0	Ba
	16	9.7	B
	16	9.4	Bu
	27	9.3	B

200916
R Sagittae

Mo.	Day	Est.	Obs.
9	26	9.1	R
10	5	9.5	R
	8	9.1	Ba
	10	8.8	R
	24	8.8	Ba
	29	8.7	M

200906
Z Aquilae

Mo.	Day	Est.	Obs.
9	30	13.4	B

200938
RS Cygni

Mo.	Day	Est.	Obs.
9	11	8.7	Ma
	26	8.3	R
10	5	8.2	R
	6	8.0	Pi
	8	7.3	Ba
	9	8.4	M
	10	7.5	Ma
	10	7.8	R
	11	8.0	Pi
	16	8.7	Bu
	26	7.3	Ma
	28	7.2	Ba
	29	7.7	Ly
11	3	7.2	G

201008
R Delphini

Mo.	Day	Est.	Obs.
10	11	12.3	B

201130
SX Cygni

Mo.	Day	Est.	Obs.
10	6	13.0	Y

201121
RT Capricorni

Mo.	Day	Est.	Obs.
9	26	7.9	R
10	5	7.9	R
	6	8.0	Pi
	10	7.3	Ba
	10	7.0	L
	16	8.8	Bu
11	1	6.5	G

201647
U Cygni

Mo.	Day	Est.	Obs.
9	26	10.3	R
10	5	9.3	R
	6	8.5	Pi
	8	7.9	Ba
	9	9.0	M
	10	9.4	R
	11	8.2	Pi
	16	8.7	Bu
	23	7.9	Ly
	27	8.2	Bu
	27	7.8	Ly
	28	7.7	Ba
	31	8.0	G
11	2	8.8	S

202539
RW Cygni

Mo.	Day	Est.	Obs.
8	30	9.3	Ma
9	8	9.3	Ma
	14	9.4	Ma
	26	9.6	R

VARIABLE STAR OBSERVATIONS Oct.-Nov., 1915—Continued.

RW Cygni

Mo.	Day	Est.	Obs.
10	5	9.5	R
	6	9.2	Pi
	8	8.7	Ba
	9	9.2	M
	10	9.4	Ma
	10	9.8	R
	11	9.1	Pi
	16	9.2	Bu
	28	8.8	Ba
	29	9.3	Ly

202817
Z Delphini

10	8	10.5	Ba
	10	10.4	O
	12	10.2	V
	16	11.0	Bu

202946
SZ Cygni

9	26	9.8	R
10	3	9.4	Ba
	5	9.8	R
	6	9.0	Pi
	6	8.2	Hu
	7	9.0	R
	8	8.5	Ba
	8	8.9	R
	9	9.2	M
	9	8.6	Ba
	10	9.4	R
	10	8.9	Ba
	11	9.1	Ba
	11	9.5	Pi
	12	9.3	Ba
	27	9.3	Ba
	28	9.4	Ba
	29	9.4	Ly

202954
ST Cygni

10	10	11.0	Hu
	11	9.9	Pi
	13	9.8	M

203226
V Vulpeculae

10	31	9.5	O
11	7	8.7	O

203611
Y Delphini

10	8	12.0	Ba
	11	11.9	B

203816
S Delphini

10	3	11.3	M
	16	11.2	Y
	27	10.6	Pi
	31	10.8	M

203847
V Cygni

Mo.	Day	Est.	Obs.
10	8	8.4	Ba
	12	9.6	M
	16	8.3	Bu
	23	9.4	M
	27	8.5	Ba

204016
T Delphini

10	3	10.8	M
	8	10.6	R
	8	11.3	Ba
	16	11.3	Y
	27	10.8	Pi
	31	12.1	M

204318
V Delphini

10	8	11.2	Ba
	10	10.7	O
	11	11.0	B
	12	10.5	Y
	27	9.4	Ba
11	3	10.5	O

204405
T Aquarii

9	26	7.3	R
10	5	8.0	R
	6	7.6	Pi
	6	7.6	Ho
	8	7.4	Ba
	10	7.9	Hu
	11	7.7	B
	16	6.8	Bu
	28	8.8	Ba
	28	8.9	Pi

204846
RZ Cygni

10	8	11.3	Ba
	12	11.1	Y
	28	11.5	Ba

205017
X Delphini

10	8	10.6	Ba
	10	11.4	O
	11	10.8	B
	12	10.7	Y
	16	11.0	Bu
	28	12.3	Ba

205923
R Vulpeculae

9	12	8.7	Ma
10	10	10.0	Hu
	31	11.2	M

210116
RS Capricorni

Mo.	Day	Est.	Obs.
9	26	8.0	R
10	5	8.2	R
	6	8.3	Pi
	10	7.7	Ba
	16	8.7	Bu
	29	8.0	M

210129
TW Cygni

10	8	11.7	Ba
	12	11.1	V
	28	12.4	Ba

210382
X Cephei

10	6	11.4	Y

210868
T Cephei

8	31	8.0	Ma
9	6	8.2	Ma
	11	8.0	Ma
	14	8.1	Ma
	26	7.5	R
	29	8.3	Ma
10	7	8.0	R
	8	6.9	Ba
	10	7.6	L
	16	7.2	O
	16	7.4	Bu
	29	7.0	Ma
11	2	6.7	S

211614
X Pegasi

10	6	11.2	O
	9	11.1	Ba

213244
W Cygni

9	26	6.0	R
10	5	6.6	R
	10	5.9	L
	16	5.7	L
11	3	5.9	G

213678
S Cephei

10	9	9.9	Ba

213753
RU Cygni

10	8	8.0	R
	13	8.4	M
11	2	8.2	G

213843
SS Cygni

8	30.5	8.2	Ma
9	1.6	9.0	Ma
	3.6	9.5	Ma
	28.6	11.9	E

SS Cygni

Mo.	Day	Est.	Obs.
10	1.7	11.7	E
	3.5	11.6	Ba
	3.6	11.5	Sp
	3.6	11.6	M
	6.5	11.6	Hu
	6.5	11.6	Ba
	6.5	11.5	Pi
	7.6	12.0	M
	8.5	11.6	Ba
	8.6	11.7	L
	8.7	11.8	E
	9.5	11.6	Ba
	9.5	11.8	B
	9.6	12.0	M
	10.5	11.5	MBa
	10.5	11.4	Ba
	10.5	11.0	Hu
	10.5	11.7	Pi
	10.6	11.0	Sp
	11.5	11.5	Nt
	11.5	11.4	Ba
	11.5	11.6	Pi
	11.6	11.5	B
	11.6	11.8	M
	12.5	11.6	Ba
	12.5	11.6	Hu
	12.5	11.6	Nt
	12.6	11.4	B
	13.6	11.3	Sp
	13.7	11.8	M
	16.6	11.6	B
	16.6	11.8	L
	17.5	11.6	Ba
	17.6	11.0	Sp
	17.6	11.6	Nt
	23.5	8.8	O
	23.6	9.2	Bu
	23.7	8.4	M
	24.4	8.3	O
	24.4	8.5	Hu
	24.5	8.3	Ba
	24.5	8.5	Bu
	24.6	8.3	M
	25.4	8.3	O
	26.7	8.6	M
	27.4	8.6	Pi
	27.4	8.8	O
	27.5	9.0	Bu
	27.5	8.8	M
	27.6	8.9	Nt
	27.6	8.6	Ma
	28.4	8.8	Pi
	28.4	9.5	O
	28.5	9.2	Bu
	28.5	9.2	Ba
	29.5	9.4	Bu
	29.5	9.8	M
	29.6	8.7	Ly
	29.6	9.6	Ma

SS Cygni

Mo.	Day	Est.	Obs.
10	30.4	9.6	Pi
	30.4	9.8	O
	30.5	9.0	Hu
	30.5	9.8	Nt
	30.6	8.6	Ly
	31.4	10.3	O
	31.5	10.4	M
	31.6	10.4	G
11	1.7	11.0	G
	3	11.2	G

213937
RV Cygni

8	30	7.6	Ma
9	8	8.0	Ma
	12	8.1	Ma
	15	8.2	Ma
	26	8.7	R
10	5	8.7	R
	6	7.9	Hu
	9	7.2	Ba
	10	8.4	Ma
	10	8.2	M
	11	8.8	Pi
	29	8.5	Ma

214024
RR Pegasi

10	4	10.4	B
	9	11.0	Ba
	11	11.2	Pi

215605
V Pegasi

10	6	13.2	Y

220613
Y Pegasi

10	10	9.7	O
	10	10.3	Pi

220714
RS Pegasi

10	10	11.6	Pi

221722
RT Aquarii

10	6	10.6	Y

222439
S Lacertae

10	8	8.9	R
	9	8.9	Ba
	27	9.8	Ba

225120
S Aquarii

10	9	11.1	Ba
	10	10.9	Pi
	27	9.0	Ba
	29	9.0	Ma

VARIABLE STAR OBSERVATIONS Oct.-Nov., 1915—Continued.

230110 R Pegasi

Mo.	Day	Est.	Obs.
10	4	10.5	O
	6	10.2	Pi
	8	10.1	R
	9	10.1	O
	9	9.9	Ba
	10	10.2	Pi
	12	10.1	O
	13	10.5	Cr
	24	9.5	O
	27	9.6	Pi
	27	9.4	Ba
	30	9.3	Ph
	30	9.6	O
	31	8.9	M
11	2	9.3	O
	5	8.9	P
	7	9.0	O

230759 V Cassiop.

Mo.	Day	Est.	Obs.
10	6	8.2	O
	8	7.4	R
	9	7.9	Ba
	16	7.8	O
	24	7.5	O
	27	7.4	Ba
	27	7.3	M
	31	7.4	M
11	2	7.8	O
	3	7.2	G
	7	7.9	O

231425 W Pegasi

Mo.	Day	Est.	Obs.
8	30	9.9	Ma
10	9	10.8	Ba
	10	10.2	Hu
	12	10.8	V
	29	10.7	Ly
	31	11.4	M

231508 S Pegasi

Mo.	Day	Est.	Obs.
10	12	11.3	O
	31	11.3	M

233335 ST Androm.

Mo.	Day	Est.	Obs.
8	30	9.5	Ma
9	6	9.3	Ma
	14	9.1	Ma
10	3	9.3	Ma
	6	9.0	Hu
	8	9.6	M
	9	9.0	Ba
	10	10.1	Pi
	11	9.6	O
	12	9.3	Ma
	16	10.0	Bu
	28	9.8	Pi
	29	9.4	Ma
11	2	9.4	S

233815 R Aquarii

Mo.	Day	Est.	Obs.
9	6	7.5	Ma
	11	7.5	Ma
10	8	8.4	R
	9	7.8	Ba
	10	8.3	Ma
	10	8.1	Pi
	29	8.5	Ma

235350 R Cassiop.

Mo.	Day	Est.	Obs.
10	4	9.2	B
	8	9.3	R
	27	7.8	M

235525 Z Pegasi

Mo.	Day	Est.	Obs.
10	6	10.0	O
	10	9.8	Ba
	10	9.8	O
	16	9.8	O
	25	9.8	O
	27	9.4	Ba
	28	9.6	V
11	2	9.6	O
	7	9.8	O

235939 SV Androm.

Mo.	Day	Est.	Obs.
10	6	10.3	B
	10	10.8	Ba
	13	11.0	B

No. of observations 1061; No. of stars observed 178; No. of observers 25.

Mr. Bancroft leads this month with 248 observations of 115 variables. In observing so many stars Mr. Bancroft has set a splendid example of efficiency. We are again indebted to Mrs. Bancroft for observations contributed to this report.

An event of importance in the variable star world occurred this past month in the publication by Houghton Mifflin Co., of a well edited and illustrated volume entitled "An Introduction to the Study of Variable Stars" by Dr. Caroline E. Furness, director of the Vassar College Observatory. The work is of especial interest to us as it places on record the steps that led up to the founding of our organization, and shows the great progress made in the observation of variables since its inception. This is the first book in English devoted to the subject of variables. It treats authoritatively and comprehensively of the subject, and should be in the hands of all variable star observers.

The recent short maximum of the variable 213843 SS Cygni was well observed. The variable reached its maxiumm on the 24th of October, and barely held it for forty-eight hours, as the observations indicate that the star had begun to wane on the 26th.

A meeting of the members of the Association will be held in Boston, Mass., on the evening of November 21. A good attendance is already assured and we expect to have with us Professor E. C. Pickering, director of the Harvard College Observatory, Mr. Leon Campbell, who has lately returned from the Harvard College Observatory Station in Arequipa, Peru, and Mr. Paul Yendell. Professor Pickering has very kindly invited our members to inspect the Observatory, a courtesy we deeply appreciate, and a privilege that will doubtless be greatly enjoyed by all who avail themselves of it.

The following members contributed to this report:—Messrs. Bancroft, Bouton, Burbeck, Crane, Eaton, Gray, Harrell, Hoge, Hunter, Lacchini, Lindsley, Mach. McAteer, Mundt, Nolte, Phillips, Pickering, Putnam, Richter, Spinney, Vrooman, Miss Swartz and Miss Young.

WILLIAM TYLER OLCOTT,
Corresponding Sec'y.

Norwich, Conn.
Nov. 10, 1915.

GENERAL NOTES.

The Rev. Father Charles M. Charropin, S. J., an astronomer and formerly head of the department of science of St Louis University, died at St. Charles, Mo., on October 17.

Mr. P. Baracchi has resigned as state astronomer of Victoria, and it is said that no appropriation will be made by the government for the Victorian Observatory at Melbourne. (*Science*, Nov. 5, 1915).

The French minister of war has appointed a consulting committee of experts on military areonautics which includes **M. Appell**, who occupies one of the chairs of mechanics at the Sorbonne, **M. Deslandres**, director of the Meudon Observatory and **M. King**, director of the Municipal Observatory. (*Science* Nov. 5, 1915).

Margaret Harwood (Radcliffe, '07), later at Harvard Observatory until June 1912, and since then, by annual award, astronomical director of the Nantucket Maria Mitchell Association, has been appointed for an indefinite term fellow of the association and director of its observatory. This year, which is the "quadrennial" provided for in the fellowship, Miss Harwood is studying at the University of California. Her new year at the Nantucket Observatory will begin June 15, 1916. A five hundred dollar Maria Mitchell fellowship for research work at Harvard Observatory will be available for the three years 1916 to 1919. (*Science*, Oct. 29, 1915.)

American Association for the Advancement of Science.—The sixty-eighth meeting of the American Association for the Advancement of Science will be held in Columbus, Ohio, December 27, 1915 to January 1, 1916. The president of the meeting will be Dr. William Wallace Campbell, the director of Lick Observatory. The address of the retiring president, Dr. Charles W. Eliot, will be given on "The Fruits, Prospects and Lessons of Recent Biological Science." The address of the retiring vice-president of the Section of Mathematics and Astronomy will be on "Poncelet Polygons". Hotel Chittenden will be the headquarters.

Adelphi College, Brooklyn, New York has just been the recipient of an outfit for instruction in Astronomy from a donor whose name is withheld. It consists of a telescope, six and one half inches aperture, with driving clock and twelve-inch circles, a six prism spectroscope which was made to order by Browning, a small transit by Steger of Kiel, and other accessory apparatus. The telescope was made by Alvan Clark in 1877, ten years before his death, and is considered an excellent instrument. All the apparatus is in perfect condition, having had the best of care by its late owner, who has recently died.

Dominion Observatory.—The annual report of the chief astronomer, W. F. King, of the Dominion Observatory, Ottawa, Canada for the year ending March 31, 1911, has just come to hand. It is published as a government document by the Department of the Interior, and is an octavo volume of 551 pages. It contains a large amount of valuable astronomical work, some of which has been published earlier in the form of separate pamphlets. Reports are given by Otto Klotz on Seismology, Terrestrial Magnetism and Gravity; by J. S. Plaskett on Astrophysical Work; by R. M. Stewart on Meridian Work and Time Service; by J. Macara on Latitude and Longitude Work; and by J. D. Wallis on work done in the Photographic Division.

Progress of Work on the 100-inch Telescope.—The steel dome for the 100-inch telescope is completely enclosed and in working order, but the exterior sheathing of the fixed portion of the building (the inner wall of which is in place), is yet incomplete. The construction and erection of the observing platform and "cage"-hoist, exterior and interior painting, etc. remain to be done. The dome turns very smoothly and easily on the rails, which were finished true after erection with a high-speed grinder carried by a radial arm pivoted at the center of the building. This is a matter of importance, as the high dispersion spectrograph for stellar spectra, to be mounted on a pier in line with the polar axis, must be free from vibration during the very long exposures which will be required.

It will give the reader some idea of the enormous size of the telescope to read that "two carloads of parts of the telescope mounting are already on Mount Wilson and four carloads are on the way from the Fore River Ship Yards at Quincy, Massachusetts, where the heavier work has been done. The balance will follow very soon, excepting the tube, which was to come by the Panama Canal, now closed to traffic because of slides. Many of the smaller parts of the mounting, including the driving clock, have been completed in our Pasadena instrument shop."

Professor Hale writes that the parabolizing of the 100-inch mirror is progressing satisfactorily in the optical shop at Pasadena and is now 85 per cent complete. The erection of the telescope mounting on its pier will be begun in 1916, after the completion of some unfinished work on the larger parts and the painting of the interior of the dome. It is not likely that the telescope can be ready for use before the spring or summer of 1917.

An International Gift.—The following account by Professor Sarah F. Whiting, of the bequest by Lady Huggins to Wellesley College, is abstracted from the *Wellesley College News* of November 4, 1915. The bequest is remarkable as coming from a person of another nationality to an institution with which she has not been connected, excepted by the ties of personal friendship and deep interest in the kind of work the college was doing.

There is now on exhibition at the Art Gallery, the bequest to Wellesley College from Lady Huggins, the well-known astronomer of the famous Tulse Hill Observatory, London.

Nearly two years ago a collection of astronomical objects from Lady Huggins was installed at the observatory. For the possession of these we have been greatly congratulated.

In February last, Lady Huggins passed into the higher life. In a letter written in her extreme illness, she stated that she had decided to leave her most personal possessions to this woman's college in the new world, but the full import of this was not understood until the fourteen cases of valuable things had escaped all perils, and been unpacked at the observatory and library.

The gift includes more than seven hundred books—the library of a most cultured person; fifty pictures, many of them Arundel, reproductions in color from the old masters; twelve small astronomical instruments,—among them the smallest spectroscope ever made, a wedding gift to Lady Huggins, also a spectroscope of historic value because it belonged to the chemist Miller, who worked with Mr. Huggins when he first began to investigate the chemistry of the stars.

There is a collection of artistic and historic jewelry, representing the craft of many nations, laces, embroideries; facsimiles and antiquities which cannot otherwise be seen except in the museums of the old world; two carved chairs of the Jacobean period, one of which was constantly used at her desk by Lady Huggins; a fine lantern clock, the case by a famous maker of about 1750, but with modern works. This will adorn the observatory mantel.

All these objects in many lines of art and archæology, have evidently been studied by the same careful scientific methods which were used in the astronomical work of which Lady Huggins did so honorable a part.

By the coöperation of Professor Brown and her staff in the Art Department, this rich gift to the College is being exhibited as a whole in one of the galleries. The exhibit will last about two weeks.

The spirit in which the gift, which will enrich so many departments of Wellesley's life, was made, is revealed in the following quotation from her last letter:

"I have always felt deep interest in America and her great mission. I have also felt increasing interest in the young women of America, and the intellectual justice now being granted to them.....I rejoice over the splendid spirit shown by the old Wellesleyans. I believe in the real great America and in Wellesley College, one of its far seeing creations. It is to Wellesley and other such colleges for young life to create the New Heaven and New Earth to which we all look forward.....So when an over-seas sister found opportunity to coöperate with the splendid educational work of Wellesley College, she did what she could, and prays that a blessing may rest upon her bequest."

On the Total Light from the Starry Sky.—The amount of total light which comes to us from the stars presents a great interest, but also encounters serious obstacles. M. Burns determined this value in 1904, while exposing in succession photographic plates to the brightness of the moon and to the light from a portion of the sky. The result obtained corresponds to nearly 27000 stars of the fifth magnitude. Newcomb and Burns measured visually the light from a surface one degree square; M. Fabry made the same measure photographically. According to these observers, the total light from the starry vault would be equal to 80,000 stars of the fifth magnitude.

The most serious cause of error of the light of the sky comes naturally from terrestrial sources. Let us suppose that it may be safely avoided. It is necessary to consider next the diffusion of light from the stars through the atmosphere; but, while comparing the brightness of diffused solar light and the brightness of the sun, it is easy to compute that the diffusion increases the total brightness but little, only one tenth of its value. It would be still necessary to keep account of the nebula and star clusters of which the brightness is difficult to estimate.

It is necessary to point out a more important cause of error. It is known that the green line of the Aurora Borealis is often noticed while pointing the spectroscope in any direction in the sky. When that is the case, allowing that the most feeble intensity perceptible is equal to one hundred thousandth of the brightness of the moon, it is found that the total brightness of the atmosphere would be 200 times greater than that of all the stars together. Therefore it must be that the green line of the Aurora Borealis is too feeble to be noticed and that, notwithstanding, its influence seriously affects the results. It would be interesting to bring about these measurements under unexceptionable conditions, for there would be then a new method for the study of the frequency of the Aurora Borealis.

Lastly, if as we have supposed, the apparent diminishing in the number of stars with the distance, is due to absorption produced by meteorites flashing through interstellar space, they must produce a diffused brightness which is added to the brightness of the stars. It is found that with the constant of absorption which we have adopted, the brightness given by the meteorites would be four or five times greater than that of all the stars together. Now, that is very nearly the relation which exists between the total brightness of the sky and the total brightness of the stars, calculated with our constant of absorption; there is a new argument in favor of our theory here.

P. SALET.
Astronomer at the Paris Observatory.

Kapteyn, while calculating the light received from all stars distributed on 41253

square degrees in the celestial sphere, found by his method that this brightness is equal to 2384 times the apparent brightness of a star of the first magnitude on the Harvard scale.

Translated from *L'Astronomie* Sept. 1915.
by ALLAN B. BURBECK.

Is Venus Inhabited.—This is the title of a little 40 page brochure by C. E. Housden, a member of the British Astronomical Association. By a train of rather fanciful though interesting reasoning the writer seeks to show the possibility of Venus being habitable. The pamphlet is published by Longmans Green & Co., London and New York. Price 50 cents net.

Stars of the Southern Skies.—This is a pleasing book by M. A. Orr, (Mrs. John Evershed). It is a small book of some ninety pages, divided into a number of chapters. Each chapter is full of interesting material such as;—the constellations, ancient and modern; the ten brightest stars of the southern hemisphere; the ages and color of the stars; peculiar stars, such as Eta Argus and Mira; variables and their causes; star-clusters, nebulae, the clouds of Magellan and the wonderful southern part of the Galaxy. There are several excellent charts of the constellations and of the mythical figures after which they were named.

The book is charmingly written and not in the least technical. It will interest especially those privileged to see that part of the heavens. It has some splendid suggestions for amateur workers.

The publishers are Longmans, Green and Company, Fourth Avenue and 30th Street, New York City. Price seventy five cents net.

THE GULF STREAM OF THE SKY.

On cloudless nights its course I used to trace,
While faring homeward on the dim-lit ways;
A pearly, sea-broad river flung thro' space,
Its isles and shores with beacon lights ablaze.

From garden, too, and casement I would scan
That drift of star dust, galaxy of spheres;
The sun's fleet arrows, swerveless, could not span
The gulf it silvers in three thousand years.

On moonless nights in town I see no more
The mystic river, awesome to behold—
Only the beacon lights along the shore,
Paled by our radiant roofs and towers of gold.

I have lain oft at night—the stars o'erhead,
The forest still, the river lisping by,
The embers of the camp fire smoldering red—
And roved that ghostly gulf stream of the sky.

ANDY.

From the Chicago Daily Tribune, Thursday, August 12, 1915.